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ABSTRACT

This self-paced, individualized course, adapted from military curriculum materials for use in vocational and technical education, teaches students the skills needed to become a qualified avionics worker and aircrew rescuer on the HH-3F helicopter. The course materials consist of four pamphlets: two student workbooks and two student syllabuses. The first pamphlet covers such subjects as rotary wing theory of flight, HH-3F familiarization, aircraft systems and communications. In order to give the student a thorough knowledge of the aircraft and systems in order to perform routine inspections and systems troubleshooting, the pamphlet includes the following aircraft systems: hydraulics, electrical, landing gear, wheel brakes, ramp, rescue hoist, auxiliary power unit, engine fire detection, heating, ventilation, anti-ice, and fuel. The second pamphlet concerns the HH-3F helicopter power train covering the main rotor assembly, transmission system, flight control system, and an in-depth study of the T58-GE-5 engine. These workbooks include reading assignments with student objectives, self-tests, and answers to the tests. The two student syllabuses contain material for the flight mechanic and for the hoist operator. (KC)

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

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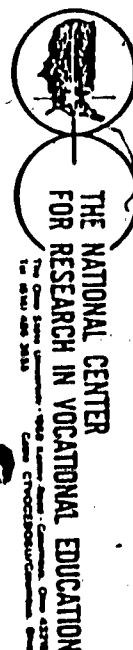
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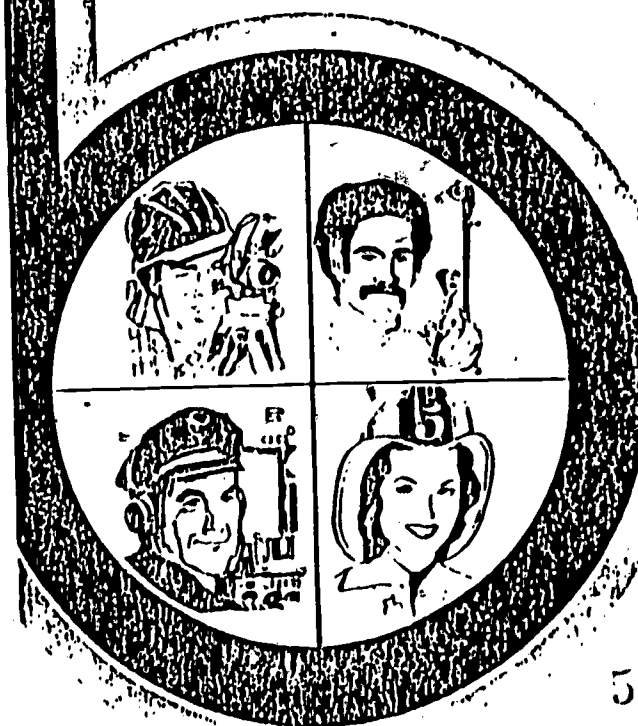
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Military Curriculum Materials for Vocational and Technical Education

Information and Field
Services Division

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Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse
Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction	Heating & Air Conditioning
Trades	Machine Shop
Clerical Occupations	Management & Supervision
Communications	Meteorology & Navigation
Drafting	Photography
Electronics	Public Service
Engine Mechanics	

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

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100 North First Street
Springfield, IL 62777
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Developed by:

United States Coast Guard

Development and
Review Dates:

7/80

Occupational Area:

Aviation

Print Pages:

307

Availability: The National Center for Research in Vocational Education; ERIC

Suggested Background:

NONE

Target Audiences:

Grade 11 - Adult

Organization of Materials:

Student workbook with objectives, assignments, tests and answers.

Type of Instruction:

Individualized, self-paced

Type of Materials:

No. of Pages:

Average
Completion Time:

HH-3F Systems

169

Flexible

HH-3F Power Train

103

Flexible

Introduction to Flight Mechanic's Syllabus

21

Flexible

HH-3F Hoist Operator Standardized Syllabus

19

Flexible

Supplementary Materials Required:

NONE

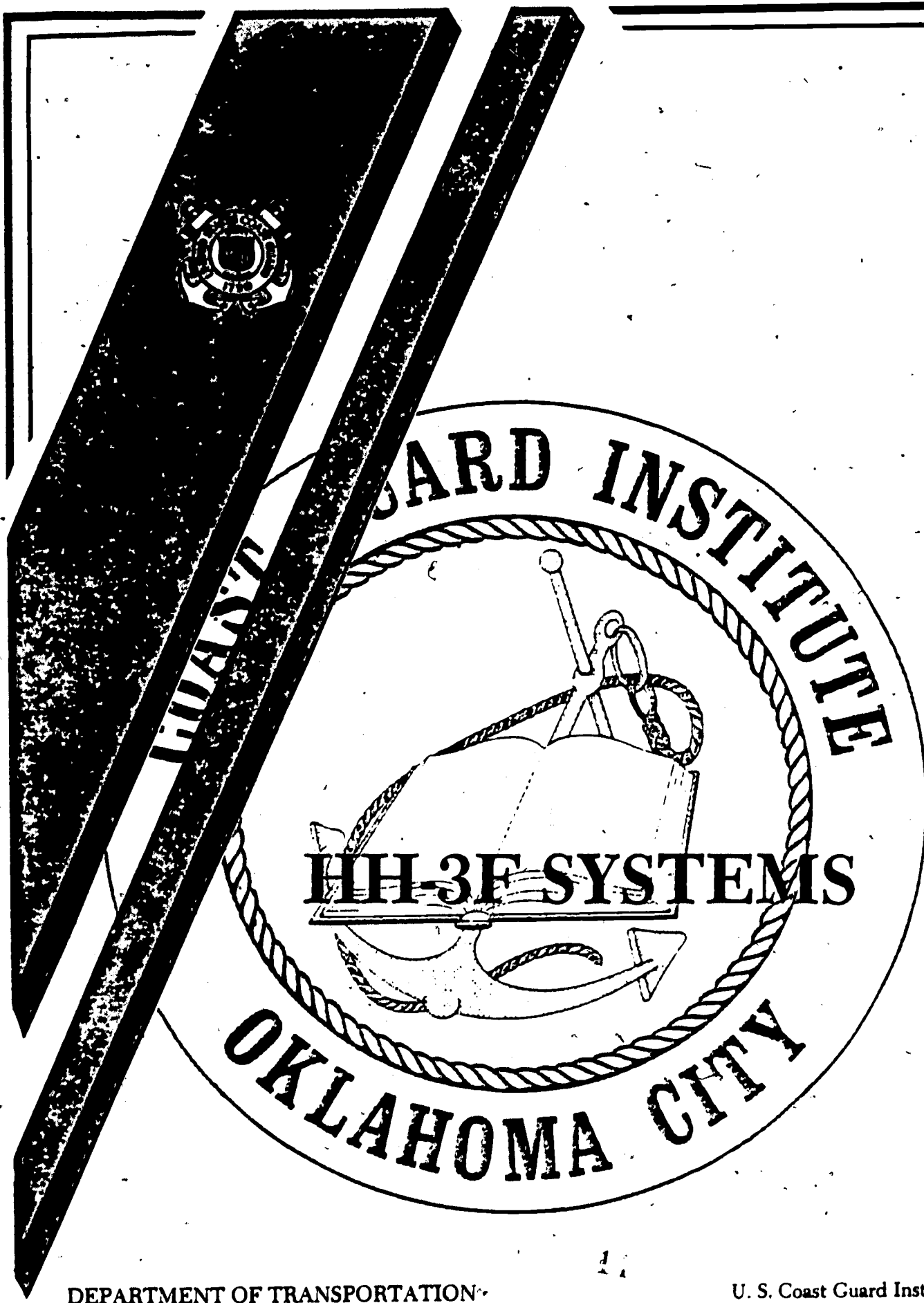
Course Description:

This course is designed for students to gain a better understanding of the HH-3F helicopter.

The first pamphlet covers such subjects as rotary wing theory of flight, HH-3F familiarization, aircraft systems and communications. A thorough knowledge of the aircraft and systems will enable one to properly perform routine inspections and systems troubleshooting. This pamphlet includes the following aircraft systems: hydraulics, electrical, landing gear, wheel brakes, ramp, rescue hoist, auxiliary power unit, engine fire detection, heating, ventilation, anti-ice and fuel.

The second pamphlet is devoted to the HH-3F helicopter power train. It covers the main rotor assembly, transmission system, flight control system and an in depth study of the T58-GE-5 engine.

Also, included are two student syllabuses. One for the flight mechanic and the second is for the hoist operator.



DEPARTMENT OF TRANSPORTATION
U.S. Coast Guard (12/80)

U. S. Coast Guard Institute
PAMPHLET NO. 659

This pamphlet contains original material developed at the Coast Guard Institute and also excerpts from:

HH-3F Flight Manual T.O. 1H-3(H)F-1

HH-3F Maintenance Manual T.O. 1H-3(H)F-2

IMPORTANT NOTE: In December, 1980, the information contained in this pamphlet was current according to the latest updates of those Directives/Publications listed. This pamphlet was compiled for training ONLY. It should NOT be used in lieu of official Directives or publications. It is always YOUR responsibility to keep abreast of the latest professional information available for your rate.

The personnel responsible for the latest review and update of the material in this component during December 1980 are:

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INTRODUCTION

This pamphlet will help you gain a better understanding of the HH-3F helicopter. We will cover such subjects as rotary wing theory of flight, HH-3F familiarization, aircraft systems, and communications.

A thorough knowledge of the aircraft and systems will enable you to properly perform routine inspections and systems troubleshooting. This pamphlet includes the following aircraft systems: hydraulics, electrical, landing gear, wheel brakes, ramp, rescue hoist, auxiliary power unit, engine fire detection, heating, ventilation, anti-ice and fuel.

Your study of the HH-3F helicopter does not stop here. When you complete this pamphlet, begin working on Pamphlet 660, HH-3F Helicopter Power train.

NOTICE TO STUDENT

This pamphlet contains lesson quizzes. Correct answers and text references are printed in the right-hand column of each quiz page. Cover the answers in the right-hand column. After you answer the questions, remove the cover to check your answer with the printed answer. Try to answer the questions in each quiz before looking back at the text.

ROTARY - WING THEORY OF FLIGHT

OBJECTIVES

When you complete this section, you will be able to:

1. Summarize the four basic forces that act upon a helicopter in flight.
2. Explain rotary-wing aerodynamics.
3. Define dissymmetry of lift and the effects of ground resonance.
4. Describe the weight limitations and explain stalls in a helicopter.
5. Explain the effects of weather on helicopter flight.

At this point it is assumed that you are familiar with theory of flight and its application to fixed-wing aircraft. Therefore, this section contains no extended discussion of the basic principles involved in the aerodynamics of flight. Instead there is only brief mention of the principles themselves, with the major emphasis on their application to the helicopter.

Although in many respects the helicopter differs radically from the conventional aircraft, rotary-wing aerodynamics is not something entirely new and different from fixed-wing aerodynamics. The same basic principles apply to both aircraft. During flight, the two types of aircraft are subjected to many of the same forces and affected by many of the same reactions.

BASIC FORCES ACTING UPON AIRCRAFT

In flight, both conventional aircraft and the helicopter are acted upon by four basic forces - WEIGHT, LIFT, THRUST, and DRAG. In addition, both types of aircraft are affected by torque reaction.

WEIGHT AND LIFT

Weight and lift are closely related in that weight tends to pull the aircraft or helicopter - down, and lift holds it up. Here is where the basic similarity between the helicopter and the airplane begins; both aircraft are heavier than air

and both are supported by the reactions of airfoils to air passing over them. This reaction, or lift is a result of pressure differential. The pressure on the upper surface of the supporting airfoil is less than atmospheric, whereas the pressure on the lower surface is equal to, or greater than, atmospheric.

The conventional aircraft's airfoils are, of course, the wings. The helicopter's airfoils are the rotor blades. One aircraft has fixed wings and the other rotary wings, but the same basic principles of lift apply to both.

The length, width, and shape of an airfoil all affect its lifting capacity. However, for any one airfoil there are only two primary factors affecting the amount of lift the airfoil will develop. The relation between these two factors - velocity of airflow and angle of attack - and their effect on lift can be expressed as follows:

For a given angle of attack, the greater the speed, the greater the lift.

For a given speed, the greater the angle of attack (up to the stalling angle), the greater the lift.

Thus, lift can be varied by varying either one of these two factors. It is obvious, therefore, that increasing either speed or angle of attack, or both, (up to certain limits) increases lift.

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Velocity of Airflow

Not only is velocity of airflow a primary factor affecting lift, but a certain minimum velocity is required in order that the airfoils may develop sufficient lift to get either an airplane or a helicopter into the air and keep it there. This means that for either the airplane or the helicopter, the airfoils must be moved through the air at a relatively high speed.

In the conventional aircraft, the required flow of air over the airfoils can be obtained only by moving the entire aircraft forward. If the wings must move through the air at 100 miles per hour to produce sufficient lift to support the aircraft in flight, then the fuselage and all other parts of the aircraft must move forward at that same speed. This means that the aircraft must take off, fly, and land at relatively high speeds. Furthermore, the aircraft is limited to forward flight; it cannot fly backwards or sideways.

It can rise vertically. It can fly forward, backward, or sideways as the pilot desires. It can even remain stationary in the air while the rotating airfoils develop sufficient lift to support the aircraft. In fact, all of these kinds of flight are normal for the helicopter.

Angle of Attack

Velocity of airflow around an airfoil is only one of the factors affecting lift. The other factor is angle of attack. For either an airplane wing or a helicopter rotor blade, the angle of attack is the angle formed by the chord plane of the airfoil and the relative wind, as shown in figure 1.

With the fixed-wing Coast Guard aircraft, the angle of attack can be varied only by changing the attitude of the entire aircraft. When, for example, the pilot wishes to climb, he pulls back on the control

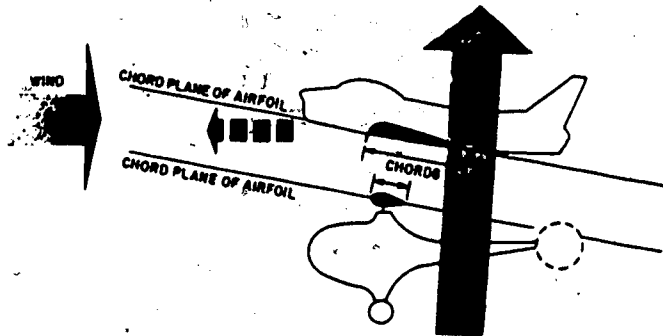


Figure 1. - Chord planes of airfoils.

The helicopter's airfoils must also move through the air at comparatively high speed to produce sufficient lift to raise the aircraft off the ground or keep it in the air. But here, the required speed is obtained by rotating the airfoils. Furthermore, the rotor can turn at the required takeoff speed while the fuselage speed remains at zero.

Thus, the speed of the airfoils (rotor blades), and the resultant velocity of airflow over them, is independent of fuselage speed. As a result, the helicopter does not require high forward speeds of the entire aircraft for takeoff, flight, and landing. Nor is it limited to forward flight.

stick or column so that the aircraft will take a nose-high attitude, thereby increasing both angle of attack and lift. When he reaches the desired altitude, he levels off to decrease the angle of attack. When he wishes to descend, he pushes forward on the stick or column, causing the aircraft to take a nose-low attitude.

The pilot can increase or decrease the helicopter's angle of attack without changing the attitude of the fuselage. He does this by changing the pitch of the rotor blades by means of a cockpit control provided for this purpose. In fact, under certain flight conditions, the angle of attack continually changes as the rotor

blade turns 360 degrees. This occurs whenever the rotor plane of rotation is tilted, as it is during forward, backward, and sideways flight. This tilting of the plane of rotation of the main rotor and the aerodynamics of the various kinds of flight are discussed later. (Plane of rotation is also known as the tip path plane and includes that area swept by the rotating blades.)

Angle of Incidence

For the airplane, the final value of the angle of attack depends on the attitude of the airplane and one other factor - the angle of incidence. The angle of incidence, for either an airplane or helicopter, is the angle formed by the chord of the airfoil and the longitudinal axis of the aircraft. The longitudinal axis of a helicopter is a line at right angles to the main rotor drive shaft.

The conventional aircraft's angle of incidence is determined by the designer and is built into the aircraft. The pilot cannot change the angle of attack.

The pilot can change the helicopter's angle of incidence at will by changing the pitch of the rotor blades. Like the angle of attack, the angle of incidence continually changes as the rotor revolves whenever the control stick is moved from the neutral position and the rotor plane of rotation is tilted. Note the comparative angles of incidence as sketched in figure 2.

Airfoil Section

Airfoil sections used for airplane wings vary considerably; each is selected to meet specific requirements. The airfoil may be symmetrical or unsymmetrical, like the ones shown in figure 3.

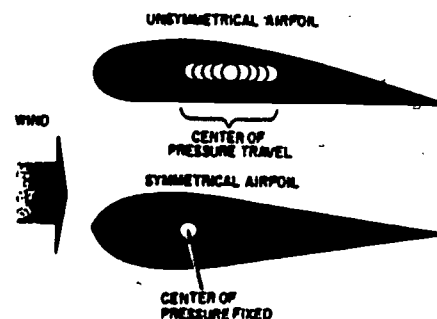


Figure 3. - Center of pressure.

An unsymmetrical airfoil may be efficient for an airplane wing, but it has one disadvantage that makes it unsatisfactory for use as a rotor blade. The center of pressure "walks" forward and rearward as the angle of attack changes. The center of pressure is an imaginary point on the airfoil where all of the aerodynamic forces are concentrated. On an unsymmetrical airfoil the center of pressure is toward the rear of the wing at small angles of attack and moves forward as the angle of attack is increased. This forward movement continues until the angle of attack is approximately the same as the angle of maximum

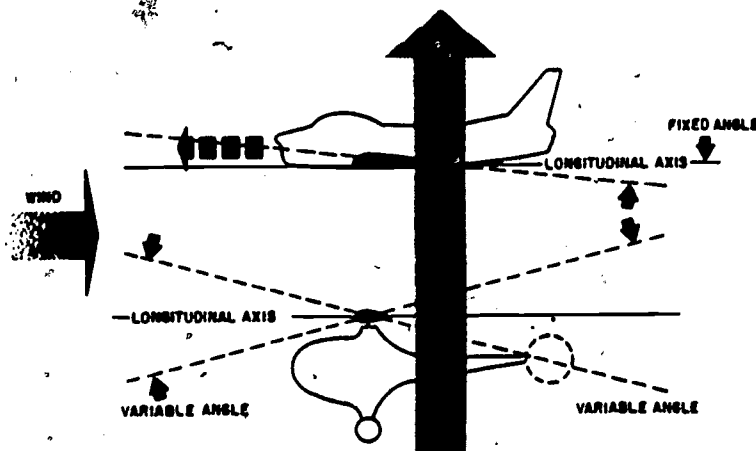


Figure 2. - Angles of incidence.

lift coefficient. (The angle of maximum lift coefficient is that angle at which 1 square foot of airfoil traveling at 1 mile per hour will produce the greatest possible lift.)

The center of pressure cannot be permitted to walk back and forth on a helicopter rotor blade, since shifting of the center of pressure would introduce pitch-changing forces. This would be undesirable and dangerous. Therefore, the center-of-pressure travel is controlled by airfoil design and is usually at a point 25 percent back from the leading edge of the rotor blade. A symmetrical airfoil has the desirable characteristic of limiting center-of-pressure travel.

THRUST AND DRAG

Like weight and lift, thrust and drag are closely related. Thrust moves the aircraft in the desired direction; drag tends to hold it back.

The conventional aircraft's thrust is, in general, forward, and drag to the rear. These forces always act in opposite directions and are usually horizontal, or only slightly inclined for the horizontal. Seldom, if ever, do these forces approach the vertical. Furthermore, the conventional aircraft's thrust can be separated and considered apart from lift. The propeller (or jet) is responsible for thrust; the wings are responsible for lift.

The helicopter gets both its lift and thrust from the main rotor. In vertical ascent, thrust acts upward in a vertical direction, while drag, the opposing force, acts vertically downward. In forward flight, thrust is forward and drag to the rear. In rearward flight, the two are reversed. In short, thrust acts in the direction of flight and drag acts in the opposite direction.

The thrust and drag forces and two of these conditions—vertical flight and forward flight—are discussed in the following paragraphs. These discussions deal with the thrust and drag forces acting on the fuselage, not with the forces within the rotor system.

During vertical ascent, thrust acts vertically upward while drag acts vertically downward. Here the drag opposing the upward motion of the helicopter is increased by the down-wash of air from the main rotor. Thrust must be sufficient to overcome both of these forces which make up the total drag. In figure 4, note that thrust acts in the same direction and in line with lift. Furthermore, the main rotor is responsible for both thrust and lift. Therefore, the force representing the total reaction of the airfoils to the air may be considered as being divided into two components. One component, lift, is the force required to support the weight of the helicopter. The other component, thrust, is the force required to overcome the drag on the fuselage. But drag is a separate force from weight, as is indicated in figure 4.

Now let us examine the thrust and drag forces acting on the fuselage during forward flight.

In any kind of flight—vertical, forward, backward, sideways, or hovering—the resultant lift forces of a rotor system are perpendicular to the tip path plane (plane of rotation). Remember, the tip path plane is the imaginary plane described by the tips of the blades in making a cycle of rotation. During vertical ascent or hovering, the tip path plane is horizontal and this resultant force acts vertically upward, as shown in figure 5. To accomplish forward flight, the pilot tilts the tip path plane forward. The resultant force tilts forward with the rotor as shown in the illustration. The total force, now being inclined from the vertical, acts both upward and forward; therefore, it can be resolved into two components as shown in the illustration. One component is lift, which is equal to and opposite weight. The other component, thrust, acts in the direction of flight to move the helicopter forward.

Although this discussion covers only two flight conditions, it should point the way to a basic understanding of thrust and drag forces acting on the helicopter fuselage during flight. In rearward flight, the thrust and drag forces are similar to those in forward flight, but are reversed. The tip path plane is tilted to the rear, the thrust components act to the rear, and drag opposes the rearward motion of the aircraft. In sideways flight, the pilot tilts the tip path plane in the desired

direction of flight, thrust is to the right or left in the direction of flight, and drag acts in the opposite direction.

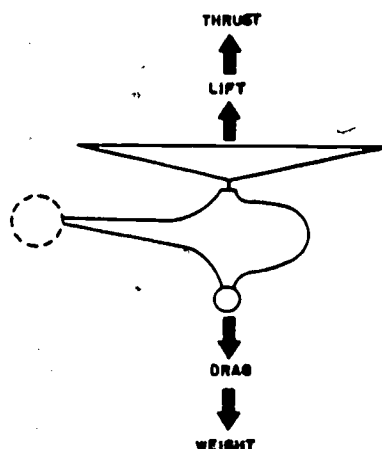


Figure 4. - Alignment of forces during vertical ascent.

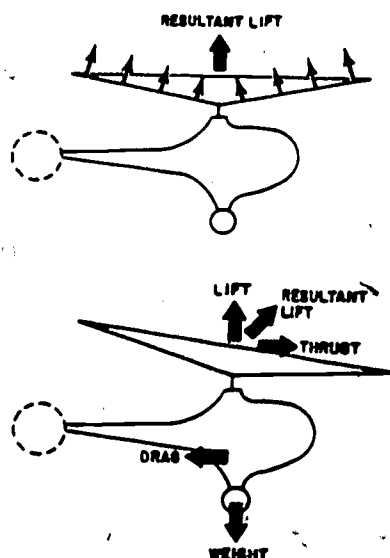


Figure 5. - Transition from vertical to forward flight.

TORQUE

As the helicopter rotor turns in one direction, the fuselage tends to rotate in the opposite direction. This torque effect is in accord with Newton's third law of motion which states that, "To every action there is an opposite and equal reaction." In the helicopter, the reaction is in a direction opposite to that in which

the rotor is driven by the engine and is proportional in magnitude to the power being delivered by the engine.

Torque is of real concern to both the designer and pilot. There must be provisions for counteracting torque and for positive control over its effect during flight. On dual-rotor and coaxial-rotor helicopters, the rotors turn in opposite directions, thus "washing out" torque reaction. In jet helicopters with engines mounted on the main rotor blade tips, the power is initiated at the rotor blade; therefore, the reaction is between the blade and the air, with no torque reaction between the rotor and the fuselage. Therefore, in helicopters of the single main rotor configuration, torque presents a problem to the pilot during flight.

The usual way of counteracting torque in a single main rotor helicopter is by means of an antitorque rotor. The auxiliary rotor is mounted vertically on the outer portion of the tail boom. The tail rotor produces thrust in a horizontal plane, opposite in direction to the torque reaction developed by the main rotor. Figure 6 shows the direction of the torque reaction and the direction of tail rotor thrust for a helicopter in which the main rotor turns from the pilot's right, to his front, to his left, and then to his rear. Most single-rotor systems turn in this direction.

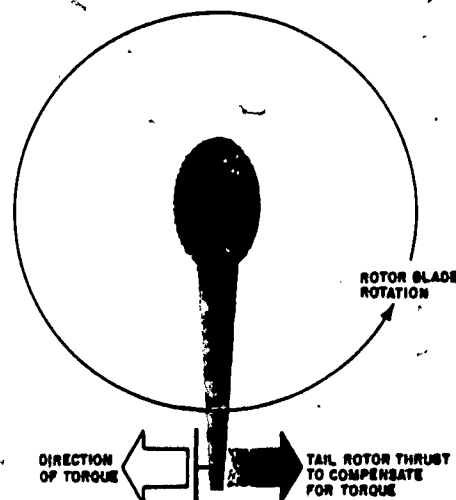


Figure 6. - Torque reaction and compensation.

Since the torque effect on the fuselage is a result of the engine power supplied to the main rotor, any change in engine power brings about a corresponding change in the torque effect. Furthermore, power requirements vary with flight conditions. Therefore, the torque effect is not constant but varies during flight. This means that there must be some provision for varying tail rotor thrust. Usually, a variable-pitch tail rotor is employed, and rudder pedals are linked by cables with the pitch change mechanism in the tail rotor gearbox. This permits the pilot to increase or decrease tail rotor thrust, as required, to neutralize the torque effect.

The tail rotor and its controls serve as both a means of counteracting torque effect and a means of heading the helicopter in the desired direction of flight. Therefore, the tail rotor control pedals serve as rudder pedals. The effect of the tail rotor controls is shown in figure 7. Applying left rudder causes the nose of the helicopter to turn to the left; applying right rudder causes the nose to swing to the right. When the pilot wishes to maintain a constant heading, he keeps just enough pitch in the tail rotor to neutralize torque effect.

Although the tail rotor is the primary means of counteracting and controlling torque, the tail rotor alone does not quite do the job. This is true because torque cannot be compensated for by a single force. The tail rotor alone would prevent rotation of the fuselage, but would cause TRANSLATION (movement in a lateral direction) of the helicopter, during hovering, in the direction of tail rotor thrust.

Complete compensation for torque requires a **COUPLE** - a pair of equal forces acting in opposite directions. Tail rotor thrust constitutes one of the forces. The second force is introduced by rigging the helicopter with the tip path plane tilted from 1 to 2-1/2 degrees to the left, depending upon the helicopter. Figure 8 shows the balance of forces on a helicopter employing a single right-to-left main rotor. Note that the slight tilt of the tip path plane to the left results in a thrust force to the left. This force and tail rotor thrust form the couple required to completely compensate for torque.

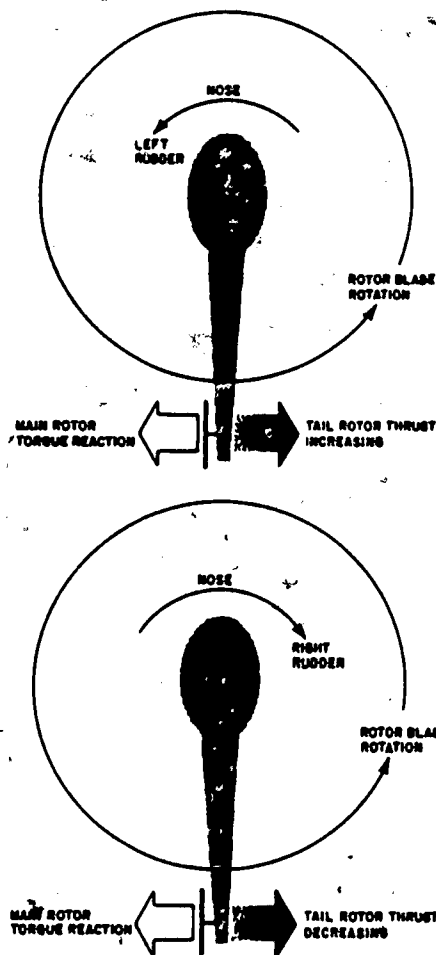


Figure 7. - Effect of tail rotor pitch changes on heading.

HELICOPTER FLIGHT

HOVERING

Hovering is the maintaining of a position above a fixed spot on the ground, usually at an altitude of about 8 feet. Helicopters normally hover on takeoffs and landings.

For the helicopter to hover, its main rotor must supply lift equal to the helicopter's weight. Lift is controlled by controlling the pitch of the rotor blades. As the blades rotate, air flows across the leading edge of each blade in the direction indicated in figure 9. The airflow crosses the leading edge of each blade throughout the

complete rotational cycle, of 360 degrees. At the same time the blades have a tendency to screw upward into the air, and air flows down through the rotor system from above, as shown in figure 10.

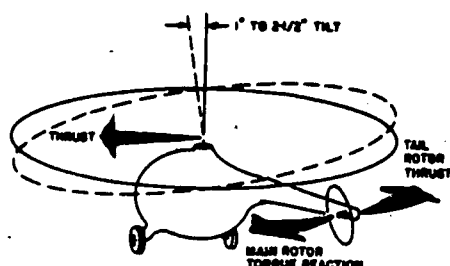


Figure 8. - Balance of forces on a helicopter.

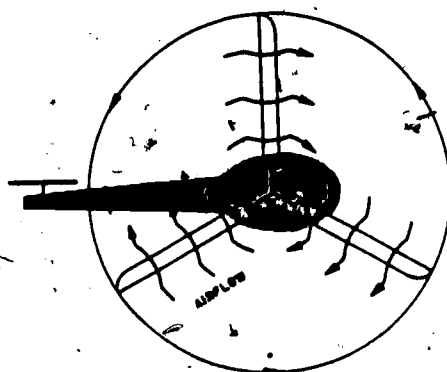


Figure 9. - Airflow across blades.

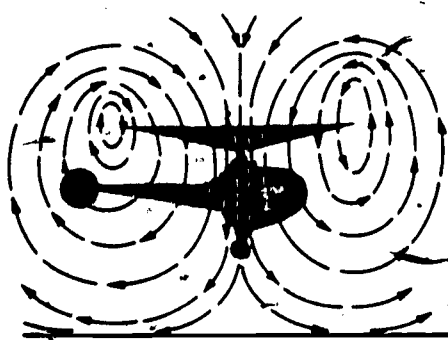


Figure 10. - Airflow through blades.

By raising or lowering the collective pitch stick, the pilot can change the collective pitch - the pitch on all of the main rotor blades - the same amount. The collective stick is operated with the left hand, as shown in figure 11. Raising the

stick increases the pitch; lowering it decreases the pitch. If the rotor rpm remains constant, increasing or decreasing the blade pitch causes the helicopter to climb or descend.

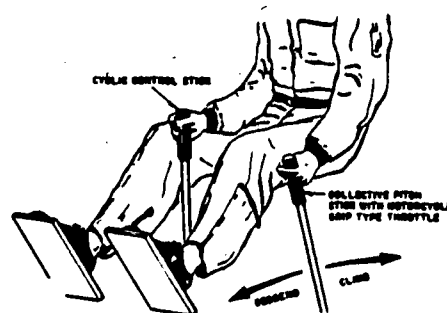


Figure 11. - Main rotor pitch controls.

To maintain constant rotor rpm during pitch change on turbine powered helicopters, the fuel control, on the engine, senses the increase or decrease of the rotor rpm and schedules fuel to the engine to compensate for it. When the collective stick is raised, the rotor blade rpm will begin to slow down due to the added load on the blades from the increase in pitch. The fuel control immediately senses this slowing down through the power turbine flex shaft and supplies more fuel to the engine. The reverse takes place when the pitch is decreased.

DIRECTIONAL FLIGHT

Vertical Flight

Vertical flight is controlled exactly the same way as hovering, since hovering is an element of vertical flight. To climb, the pilot raises the collective pitch stick. At the same time, the cyclic control (discussed under "Horizontal Flight") is held in a near neutral position, so that lift will be vertical. The flow of air is still over the leading edge of each blade, but the helicopter is now moving upward, as shown in figure 12.

When the helicopter is climbing vertically, the main rotor supplies not only the lift necessary to support the helicopter's weight, but also the thrust necessary to cause the helicopter to rise vertically. To descend, the pilot lowers the collective pitch stick to decrease main rotor pitch and the resultant lift.

Horizontal Flight

Horizontal flight is controlled by tilting the tip path plane in the direction of desired flight - forward, backward, to the left, or to the right. As detailed in figure 12, the helicopter moves in the direction the tip path plane is tilted.

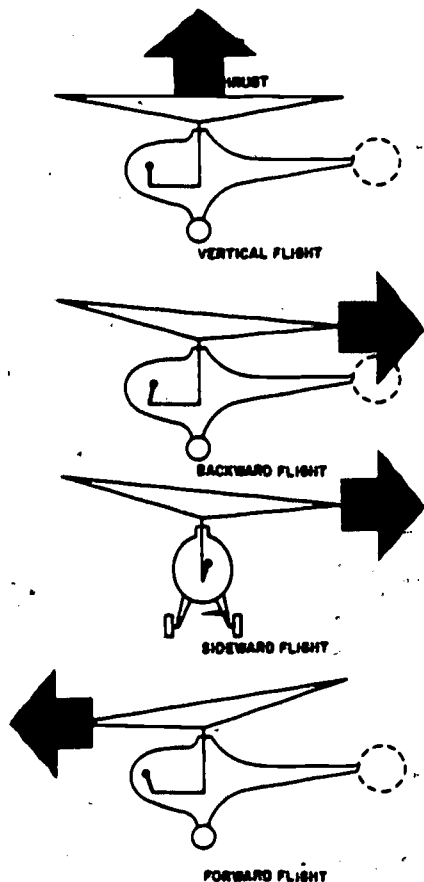


Figure 12. - Directional flight attitudes.

The pilot tilts the tip path plane by means of the cyclic pitch control. This control provides a mechanical means of changing the pitch of the main rotor blades in any direction of tilt throughout their full 360 degrees of rotation. Cyclic pitch change is equal and opposite, as shown in figure 13. If the blade pitch is increased 3 degrees on one side of the rotor center, at a point 180 degrees around the cycle of rotation, the blade pitch is decreased 3 degrees.

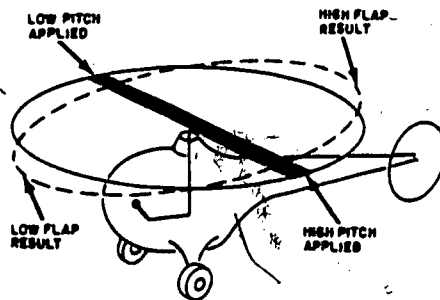


Figure 13. Pitch changes for forward flight.

For every pitch change, there is a resulting flapping action of the individual blades, as they constantly change pitch during rotation. As is shown, maximum flapping takes place 90 degrees around the cycle of rotation from the place where the pitch change was applied. The equal and opposite pitch change and the resulting flapping of the individual blades causes the tip path plane to tilt in the same direction as the pilot moves the cyclic control stick. Thus, to fly forward, backward, sideways, or in fact, any direction horizontally, the pilot must tilt the cyclic control stick in the desired direction. Coordination of the tail rotor pedals may be required to neutralize torque effect.

Combination Changes of Direction

To climb or descend while moving forward, backward, or to either side is merely a matter of coordinating the movements of the collective pitch control, which governs vertical flight, and the cyclic control, which governs horizontal flight. The tail rotor counteracts torque and is used to change the heading of the helicopter.

Takeoffs

Helicopter takeoffs are vertical climbs. For normal takeoff, the engine is run up to the stipulated takeoff power; then the collective pitch stick is raised gradually to increase the rotor blade pitch until the helicopter rises into the air. The cyclic control stick is held in a near neutral position so that the helicopter will rise vertically.

At a height of about 6 feet, the collective pitch is adjusted to maintain this position, hovering above the takeoff spot in preparation for movement in the desired direction of travel.

Ground Cushion

As the helicopter rises from the ground in a hovering attitude to a height of 6 or 8 feet, a cushion effect is built up under the helicopter. This is commonly called ground cushion or ground effect. The ground cushion develops because air is packed between the main rotor blades and the ground. As shown in figure 14, the downward flow of air strikes the ground and is partially trapped under the main rotor system. The air packs because it cannot escape as rapidly as the downward flow of air established by the main rotor blades; therefore, a cushion of slightly compressed air is built up.

Boyle's Law states that the density of any gas varies directly as its pressure. The greater the density of air, the greater the efficiency of both the engine and the rotor system. The ground cushion is established to a height equal to the rotor diameter, but is effective only to a height of approximately one-half the rotor diameter. Correspondingly, there is more power available for hovering near the ground, that is, within a height of one-half rotor diameter. The ground cushion effect is lost at airspeeds in excess of 10 miles per hour.

Translational Lift

Translational lift is the additional lift developed as the helicopter accelerates into forward flight. Translational lift becomes effective at an airspeed of approximately 15 miles per hour, and it continues to increase with forward speed. However, at high values of forward speed parasite drag increases more rapidly than translational lift.

Since vertical lift increases and then decreases with changing values of forward speed, at some airspeed it must reach a point of maximum. This speed is known as the most efficient airspeed, and it will remain approximately constant for a particular type of helicopter. For example, the most efficient airspeed for a typical helicopter may be 60 knots. At its most efficient airspeed, a helicopter will have its best rate of climb, least rate of descent for a given power setting, and maximum endurance.

When hovering 6 to 8 feet above the ground in a no-wind condition, the helicopter is aided by the ground cushion effect. As the helicopter enters forward flight, it slides off the ground cushion, and reduced lift will cause the craft to settle. The pilot increases pitch to prevent contact with the ground. However, when a forward speed of approximately 15 mph is reached, translational lift becomes effective and the helicopter will gradually climb. As forward speed is increased, lift is increased and less power will be required to maintain straight and level flight.

From the hovering position, 6 to 8 feet above the ground, the pilot prepares to move into forward flight. As he moves the cyclic stick slightly forward, causing the tip path plane to tilt forward, the helicopter settles toward the ground for two reasons. First, the helicopter moves off its ground cushion, losing the support of the denser air. Second, the power of the main rotor system is no longer devoted completely to lift, but is now divided between lift and thrust.

At 5 mph the helicopter is losing some of its ground cushion and has a shorter lift vector, so it settles slightly toward the ground. At 10 mph it is still settling. But at 15 mph there is a noticeable increase in lift, which will continue as forward speed is increased. This additional lift, which becomes available at about 15 mph, is called translational lift.

Many efforts have been made to explain translational lift. Perhaps the most plausible explanation is that a helicopter must travel about the distance covered in reaching 15 mph to enter a clear air region. Whatever the explanation, a helicopter definitely will have greater efficiency and greater lift when it reaches a forward speed of 15 mph and beyond.

Helicopters usually take off into the wind; hence, the greater the velocity of the wind, the sooner a helicopter will enter into translational lift. In a 15 mph wind, for example, a helicopter will hover in translational lift following take-off. It will not settle as it moves forward, providing the takeoff is into the wind.

ROTARY-WING AERODYNAMIC EFFECTS

A helicopter is subject to several rotary-wing aerodynamic effects, which we will now consider.

AUTOTOTATION

Autototation, sometimes called "windmilling," is the process of producing lift with airfoils which rotate freely as the air passes from the bottom up through the rotor system. Under power-off conditions, the helicopter will descend; thus the airflow will be established from the bottom upward through the rotor system. The rotor

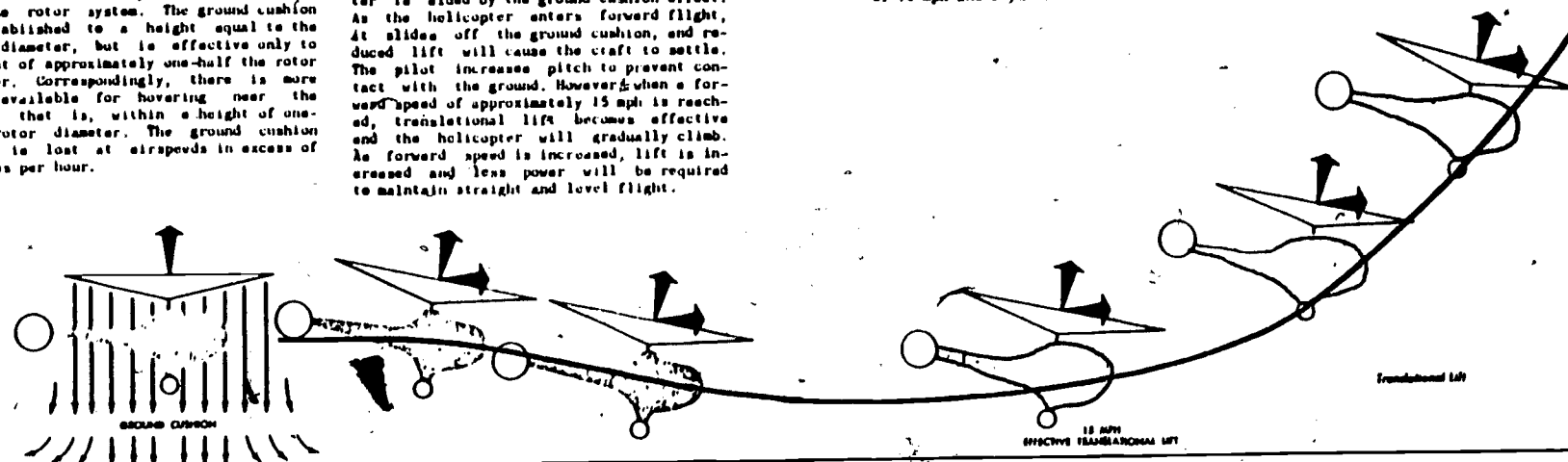


Figure 14. - Ground cushion and translational lift.

is automatically disengaged from the engine, and the necessary power required to overcome parasite and induced drag of the rotor blades is obtained from the potential energy due to the helicopter's weight and height above the ground. This potential energy is converted into kinetic energy, which is used to rotate the overhead rotor system during descent.

Autorotation is the principle used in the flight of the autogyro to provide lift. A helicopter uses autorotation for emergency landings in case of engine failure.

During autorotation, the rotor blades turn in the same direction as when engine-driven, but the air passes upward through the rotor system, causing a slightly greater upward flexing or coning of the rotor blades. Since the engine is not driving the rotor, there is no torque effect on the fuselage during autorotation.

While the helicopter is in autorotation, it is essential that the pitch of the rotor blades be reduced materially to minimize drag, thus permitting a high rotor rpm to build up. When the pitch angle of the main rotor blades is low (as shown in figure 15) the resultant lift force lies ahead of the axis of rotation, tending to keep the blade turning in its normal direction of rotation.

Figure 16 shows a condition in which the blade pitch angle is too high for satisfactory autorotation. Note that drag is

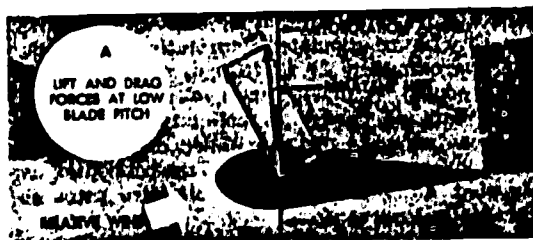


Figure 15. - Lift and drag forces at low blade pitch.

increased and the resultant lift force lies behind the axis of rotation, slowing the rotor.

The pilot must reduce the pitch in order to keep the rotor blades turning at sufficient speed to maintain the required centrifugal force. Otherwise, the blades will fold up and the helicopter will tumble out of control.

If the engine fails during flight, a safe autorotation can be accomplished, provided the helicopter is being flown at a safe altitude-airspeed combination and the inflight altitude is sufficient to permit selection of a suitable landing area. When altitude permits, an engine air restart may be attempted. If the engine fails to start, a power-off landing must be made. Collective pitch must be reduced for autorotation and a glide established at the most efficient airspeed with the stipulated autorotative rotor rpm. At a predetermined altitude (140 feet or 200 feet, depending on the type of Coast Guard helicopter), the nose of the helicopter is rotated up with aft cyclic to reduce the airspeed and the rate of descent. This maneuver is referred to as a flare. When the desired reduced airspeed and altitude are obtained, the cyclic stick is moved forward to position the helicopter in the desired attitude for landing. The collective stick will now be used to control the rate of descent when the helicopter is approaching the ground. The collective is not used to stop the rate of descent, but to establish a very low sink rate at surface contact. After ground contact, the collective stick is lowered to minimum pitch.

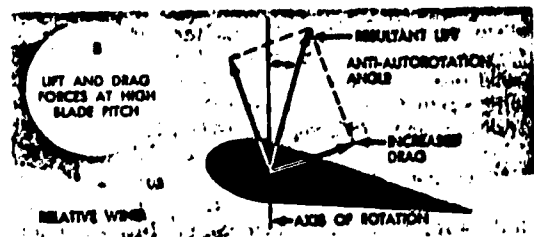


Figure 16. - Lift and drag forces at high blade pitch.

REVIEW

The same basic principles of aerodynamics and theory of flight apply to both the helicopter and the fixed-wing aircraft. However, a comparison of the blade and wing shows how these two types of aircraft differ. Although the blade and wing are both lift-producing airfoils, an aircraft wing is fixed, but the helicopter blade is moveable. Also, movement of the blade changes the direction of helicopter flight, whereas the primary control surfaces perform this function on a fixed-wing aircraft.

The "basic forces acting on an aircraft" and some of the "rotary-wing aerodynamic effects" were covered in this section.

(Now answer the following review questions.)

1. Which combination of pressures on the upper and lower surfaces of an airfoil will produce lift?

- A. Upper - equal to atmospheric
lower - equal to atmospheric
- B. Upper - greater than atmospheric
lower - equal to atmospheric
- C. Upper - less than atmospheric
lower - equal to atmospheric
- D. Upper - equal to atmospheric
lower - less than atmospheric

1.-C

When pressure on the upper surface of an airfoil is less than the pressure on the lower surface, lift is produced. (Refer to page 1)

2. The two PRIMARY factors affecting the amount of lift an airfoil will develop are the angle of _____.

- A. incidence and the chord plane of the airfoil
- B. incidence and the center of pressure travel
- C. attack and the transition of forces
- D. attack and the velocity of airflow

2.-D

As the angle of attack and the velocity of airflow increase, pressure on the lower surface of the blades increases and lift is greater. (Refer to page 1)

3. Symmetrical airfoils are used for helicopter blades because the center of pressure on this type of airfoil is fixed.

- A. True
- B. False

3.-A

On unsymmetrical airfoils, the center of balance will walk back and forth on the rotor blade as the angle of attack is changed. This introduced pitch changing forces. (Refer to page 3 and 4)

4. Regardless of the direction of helicopter flight, what force always acts in the opposite direction to thrust?

- A. Lift
- B. Velocity
- C. Gravity
- D. Drag

4.-D

Any type of drag on an aircraft surface tends to hold the aircraft back. (Refer to page 4)

5. Single-rotor helicopters are rigged with the main rotor tip path plane tilted slightly to the left in order to _____.

- A. ensure positive stability during autorotation
- B. prevent blade stall during autorotation
- C. offset tail rotor thrust during hovering
- D. offset main rotor torque during hovering

6. A vertical climb in a helicopter is initiated by _____ pitch control.

- A. raising the cyclic
- B. lowering the cyclic
- C. lowering the collective
- D. raising the collective

7. As a helicopter accelerates into forward flight, additional lift is developed. This is called _____ lift.

- A. translational
- B. effective
- C. secondary
- D. symmetrical

8. A helicopter will settle when it moves from a hover to forward flight because _____.

- A. it moves off its ground cushion
- B. engine power is devoted completely to thrust
- C. the air into which it moves is denser
- D. the effects of translational lift are lost

9. What is the purpose of the "flare" in an autorotation?

- A. Reduce the airspeed and the rate of descent
- B. Reduce the airspeed and increase the rate of descent
- C. Establish a very low sink rate at surface contact
- D. Position the helicopter in the desired attitude for landing

5.-C

Tail rotor thrust offsets the main rotor torque, and the tilt to the main rotor trip path plane offsets the thrust of the tail rotor. (Refer to page 6)

6.-D

Raising the collective increases the pitch on all the rotor blades at the same time. By increasing the pitch, you will create more lift and the helicopter will climb. (Refer to page 7)

7.-A

This additional lift is due to the increase in the velocity of airflow. This occurs at about 15 mph. (Refer to page 9)

8.-A

As a helicopter moves off its ground cushion, it will lose a small amount of lift and tend to settle. (Refer to page 9)

9.-A

As the aircraft flares out, the angle of attack is greatly increased and speed is decreased. (Refer to page 11)

DISSYMMETRY OF LIFT

Dissymmetry of lift is the difference in lift which exists between the advancing half of the disc area and its retreating half when the helicopter is in horizontal flight. (The disc area is that swept by the rotating blades.)

When the helicopter is hovering motionless in still air, the lift created by the advancing and retreating halves of the disc area is equal. But when the helicopter is moving forward, the forward speed of the aircraft is added to the rotational speed of the advancing blade and subtracted from the rotational speed of the retreating blade. (See figures 17 and 18.)

The coefficient of lift (C_L) is determined by airfoil shape. Most helicopters use symmetrical rotor blades, because symmetrical rotor blades perform well whether the flow of air is from the top downward through the rotor system, as in powered flight - or from the bottom upward as in autorotative flight. Also as mentioned previously, a symmetrical airfoil limits the travel of the center of pressure, which is very important because center-of-pressure travel would introduce pitch-changing moments on the blades.

Density of the air depends, of course, on temperature, moisture, altitude, and so forth.

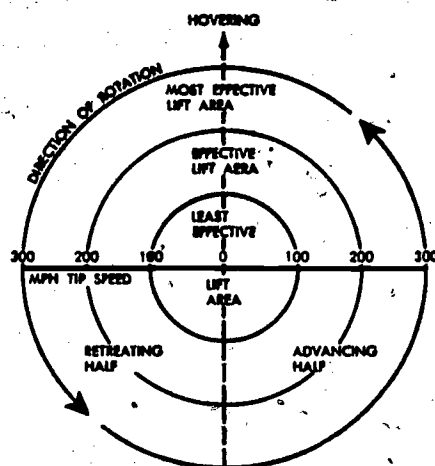


Figure 17. - Zero airspeed - symmetry.

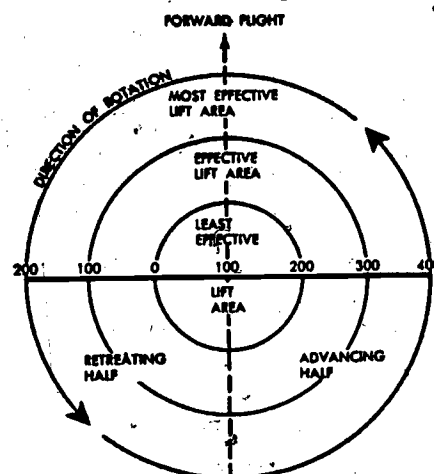


Figure 18. - Forward speed - dissymmetry.

Velocity, as we have seen, is the product of two factors: the speed of the blades and the speed of the helicopter itself.

It is obvious that three factors of the basic lift formula are the same for both advancing and retreating blades. These are C_L , D , and A . The only variable is V , velocity. Therefore, lift varies according to the square of the velocity.

Now let us consider some specific values. The tip speed of some helicopter rotors is about 350 mph at normal takeoff rpm. In these examples, however, we will use a tip speed of 300 mph to simplify arithmetic. Also, we will consider only the tip speed although rotational speed varies from about 350 mph at the tip of the blade to a considerably slower speed at the rotor head.

When the helicopter is hovering, the velocity of the advancing blade is 300 mph. The velocity of the retreating blade is the same, 300 mph. Therefore, the lift created by the advancing blade is the same as that of the retreating blade. (See figure 17.)

Now consider the velocity of the blades when the helicopter is moving forward, as in figure 18, at a speed of 100 mph.

The advancing blade has a tip speed of 300 mph plus the helicopter speed of 100 mph, or 400 mph. V^2 is 160,000.

The retreating blade has a tip speed of 300 mph minus the helicopter speed of 100 mph, or 200 mph. V^2 is 40,000.

The lift created at the blade tip is in the ratio of 160,000/40,000, or four times as much for the advancing blade than for the retreating blade. If such dissymmetry of lift were allowed to go uncorrected, the helicopter would turn over.

The normal correction for dissymmetry of lift is to incorporate a flapping hinge in the rotor head. This device equalizes lift on the advancing and retreating blades. The hinge permits an advancing blade to rise, thus reducing its effective lift area. The hinge also allows a retreating blade to settle, increasing its effective lift area. Thus, the blades position themselves aerodynamically to equalize lift on the advancing and retreating halves of the disc area.

PENDULAR ACTION

It is normal for the fuselage of a helicopter to act like a pendulum, that is, to swing laterally and longitudinally. This pendular action can be exaggerated by over-controlling; therefore, control stick movements should be decidedly moderate. Also, because of this normal pendulous action, it is wise to keep the wheels of a helicopter at least 5 feet above the ground while hovering. (See figure 19.)

It is also normal for the helicopter to take a nose-low attitude in forward

flight, and a nose-high attitude in rearward flight. This is caused by the fact that the drive shaft lines up in the same straight line as the resultant lift vector.

RESONANCE

A helicopter is subject to two types of resonance -- sympathetic resonance and ground resonance.

Sympathetic resonance is a harmonic beat between main rotor and tail rotor systems, which could shake the helicopter to pieces. This unsatisfactory condition has been engineered out of helicopters by designing the main and tail gear boxes in odd decimal ratios. Thus, the beat of the main rotor cannot harmonize with the beat of the tail rotor. There is no known case of helicopter destruction caused by sympathetic resonance.

Ground resonance may develop whenever the center of mass of the rotor system becomes unseated. This usually occurs during landings, when the helicopter is 87 to 95 percent airborne. Ground resonance develops when the aircraft is light on its wheels, and one wheel of the main landing gear hits the ground and then the other wheel hits. Such successive shocks tend to cause the blades straddling the wheel hitting the ground to move down and to change their angular relationship. If a similar reaction takes place when the opposite wheel hits the ground, resonance may develop. (See figure 20.) This sets up a pendulum-like oscillation of the fuselage, which continues when

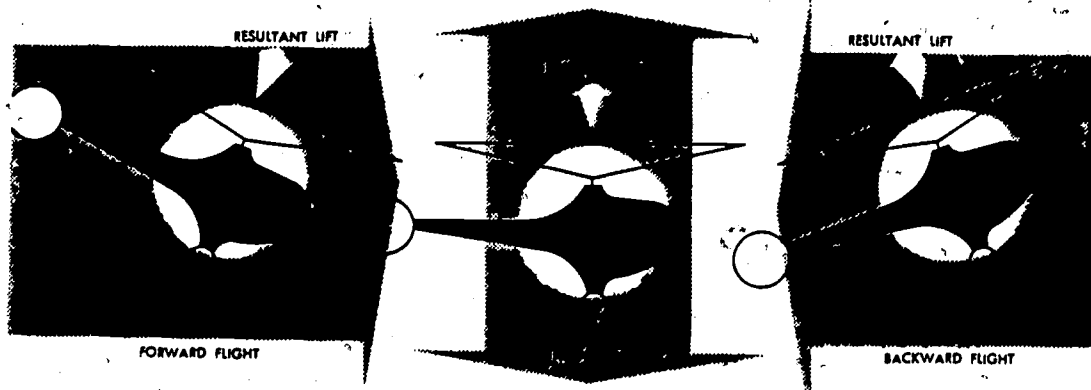


Figure 19. - Pendular action.

once established until some force shocks the system sufficiently to interrupt the beat. This oscillation usually leads to structural failure.

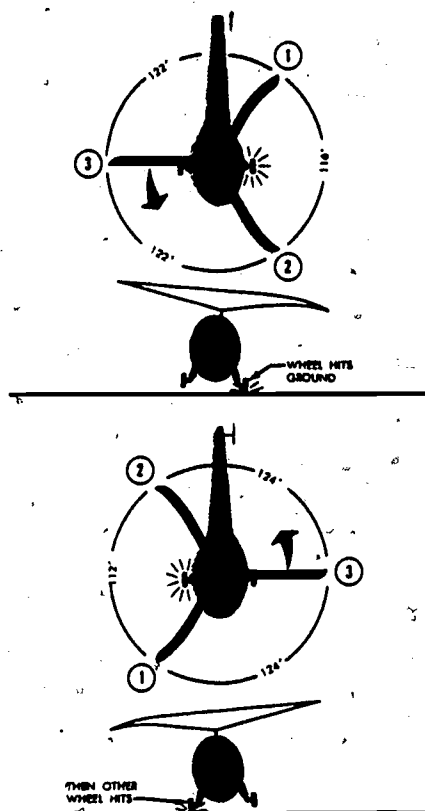


Figure 20. - Effect of ground resonance.

If ground resonance should occur with high power, the pilot must immediately increase pitch and takeoff. The resonance will stop when the helicopter becomes airborne. If ground resonance should occur with low power, the pilot must immediately decrease rotor rpm further by decreasing throttle and applying both the rotor brake and the wheel brakes. If ground resonance should occur on a landing, increase throttle and collective pitch and hover. Seek a softer spot to make a landing because a shock strut or damper may be malfunctioning.

To reduce the possibility of ground resonance occurring during takeoff, steadily increase main rotor pitch until the wheels are clear of the ground. During landings, steadily decrease collective pitch as the wheels contact the ground.

GYROSCOPIC PRECESSION

Gyroscopic precession is an innate quality of all rotating bodies, in which an applied force is manifested approximately 90° in the direction of rotation from the point where the force is applied. Thus, in figure 21, if a downward force is applied to the right of the disc area, gyroscopic precession will cause the disc area to tilt down in front, provided that the rotor system is turning from right to left. The applied force is pitch change on the main rotor blades, which is regulated by the cyclic control.

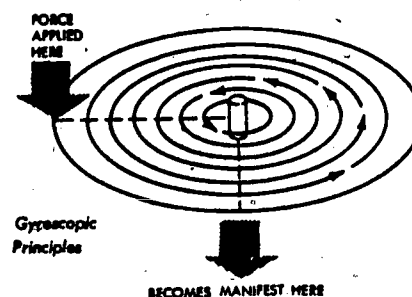


Figure 21. - Gyroscopic principles.

To simplify directional control, helicopters employ a mechanical linkage (figure 22), which actually places cyclic pitch change of the main rotor blades 90° ahead in the cycle of rotation. Thus, if the cyclic control is moved forward (in case of a rotor system turning from right to left), high pitch is applied to the blade on the pilot's left and low pitch is applied to the blade on his right. Since every pitch change causes a flap, reaching its maximum approximately 90° around in the cycle of rotation, this flapping will cause the disc area to tilt forward.

As you can see, if this offset linkage were not employed, the pilot would be required to move the cyclic stick 90° out of phase, or to the right when he wanted to tilt the disc area forward, and forward when he wanted to tilt the disc area to the left, and so on.

WEIGHT LIMITATIONS

There is no single answer to the maximum weight at which a helicopter can be operated. The maximum permissible weight of a helicopter varies within broad limits, depending upon certain weight controlling

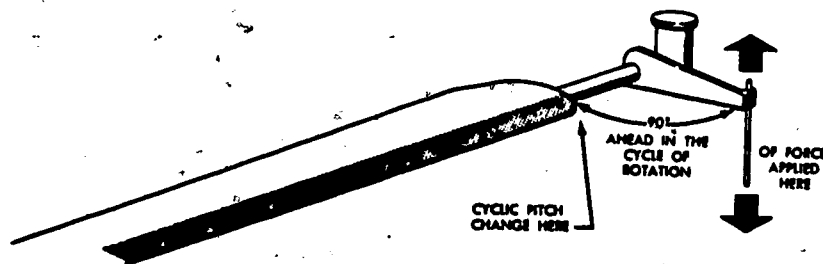


Figure 22. - Mechanical linkage.

criteria. The maximum weight of a helicopter becomes a variable quantity to produce optimums under different conditions. The weight limitation charts for a particular type helicopter provide flight personnel with operational gross weight information. However, it is readily understandable that as a structure is loaded to higher weights, its ability to withstand shocks or additional loads resulting from maneuvers becomes increasingly less.

The margin of safety is the amount of shock or additional load that the structure will sustain before failure occurs. In planning any helicopter mission, the fact must be recognized that the maximum permissible weight may depend on the margin of safety desired for the various supporting structures, such as the main rotor, fuselage, landing gear, flooring, etc. Should the mission require excessive maneuvering or flight through turbulent air, it would be advisable to maintain a larger margin of safety than if smooth, level flight were contemplated.

In regard to helicopters, load factors are used as an indication of the margin of safety that is available. At any particular moment of operation the structural margin of safety, for example, will be equal to the difference between the load factor the helicopter is designed for, and the load factor the helicopter is sustaining at that given moment. For any specific helicopter, the weight limitations are based on the basic operating weight as determined by structural engineers and flight test data. The helicopter pilot should make certain that he thoroughly understands the weight limitations before flight. The fact that a helicopter can take off with a heavy load is no assurance of a safe flight.

WEIGHT AND BALANCE

The permissible center-of-gravity (CG) travel is very critical in many helicopters. In fact, some helicopters have only a 4-inch maximum travel. If a helicopter is improperly loaded, not only does the fuselage tilt off the horizontal, but the rotor mast which is attached to the fuselage tilts the entire rotor system. The cyclic stick controls the amount and direction of tilt of the rotor system, but the travel on the cyclic control stick is limited.

The amount of back-stick the pilot can apply to the cyclic control to level the rotor system is limited by the manner in which the helicopter is rigged. If the helicopter is dangerously nose-low, the pilot may find that when he pulls the cyclic control back as far as it will go, the helicopter's attitude remains nose-low, and the rotor system still tilts forward. The pilot cannot slow the helicopter, nor can he raise the nose to land. Needless to say, he then finds himself in a dangerous predicament. (See figure 23.)

In newer helicopter designs, efforts have been made to locate the loading com-

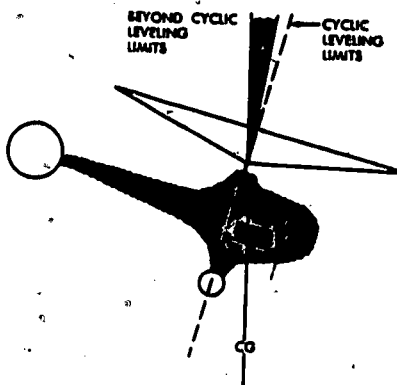


Figure 23. - Excessive loading forward of center of gravity causes dangerous nose-low attitude.

partment directly under the rotor shaft to minimize CG travel. For the same reason, the fuel supply may be located at or near the balance point, which is normally at the main rotor shaft. However, the fact remains that the pilot must at all times balance his load so as to remain within CG travel limits. He should be well informed as to the CG travel limits of his particular helicopter and should exercise great care in taking on loads.

Here again, we can refer to the tandem rotor-type helicopters. The wide center of gravity range is an advantage over the single-rotor helicopter.

STALLS

Stalling, as applied to a fixed-wing aircraft, will not occur in a helicopter. However, a power settling may occur in low-speed flight, and blade stall may occur in high-speed flight.

POWER SETTLING

Power settling is the uncontrollable loss of altitude. This condition is aggravated by heavy gross weight, unfavorable density conditions, low forward speed, or operating with reduced power. When the rate of descent approaches 200 feet per minute

with an airspeed of 10-15 knots, roughness and partial loss of control may occur. At this rate of descent and low airspeed, the downwash from the rotor begins to recirculate - up, around, and back down through the effective outer rim of the rotor disc. The velocity of this recirculating mass of air may become so high that full high-collective pitch will not produce sufficient lift to retard or control the rate of descent. (See figure 24.)

To recover from this condition, increase forward speed and reduce pitch. An altitude loss of 400 to 700 feet may occur before the condition is recognized and recovery is complete. During approach for landings, and descent or takeoff above congested areas, the pilot should avoid the conditions causing power settling.

BLADE STALL

A flight characteristic that has caused a number of helicopter accidents is the blade stall or blade tip stall. The stall usually occurs at the tip of the retreating blade due to high angle of attack and slow airspeed of the retreating blade. The stalled blade sections are localized and exist throughout only a small portion of the rotor disc, as shown in figure 25.

During flight conditions with high values of forward speed, gross weight, and

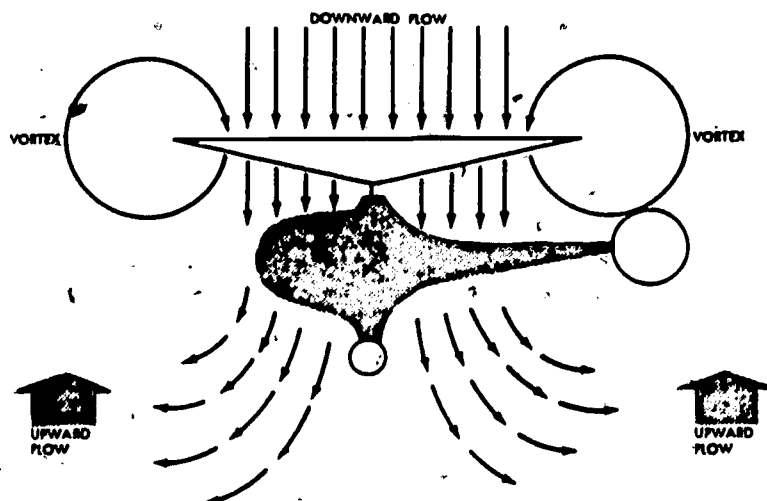


Figure 24. - Power settling.

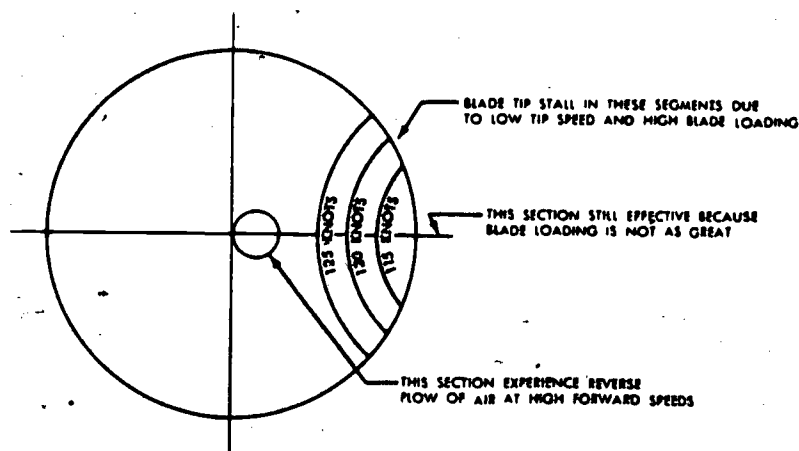


Figure 25. - Blade stall.

altitude, the retreating blade has an excessive angle of attack and low airspeed. These conditions aggravate blade stall. Mild blade stall will cause a roughness in both the helicopter and flight controls. Severe blade stall will cause an abrupt pitch-up of the nose of the helicopter. Although the retreating blades stall on the pilot's left, the loss of lift is manifested at a point 90° later, causing the tip-path plane to tilt downward toward the rear. The uncontrolled pitch-up will last only for a very short period as full control is restored automatically when airspeed decreases in the nose-high attitude and the excessively high angle of attack no longer exists. (See figure 25.)

When blade stall occurs, the controllability of the helicopter will diminish. If such vibrations and control kicks are noticed, the pilot may easily eliminate the stall by accomplishing any one or a combination of the following:

1. Reduce collective pitch
2. Increase rotor rpm
3. Decrease severity of the maneuver
4. Gradually decrease air speed

In general, it can be stated that blade stall occurs when the rotor is excessively loaded. Turbulence can also cause blade stall due to sudden high blade loading. The general rule for the elimination of blade stall once it is suspected is to unload the rotor.

WEATHER

The flight characteristics of a helicopter are noticeably affected by the existing density conditions. For example, at sea level on a cool day the average helicopter demonstrates ample power and lift. However, on a very hot day at sea level the same helicopter is apt to be underpowered, and flight may become critical because of the less dense air conditions. The alert helicopter pilot shrewdly evaluates the existing density conditions, for experience has taught him to alter technique for landing, take-off, or autorotation, if such an emergency should arise.

Variation in density conditions will not only affect the efficiency of the main rotor blades as they bite into the air, but engine efficiency also will be altered. As the fuel-air ratio varies, so will the available engine power.

The air surrounding the earth extends upward for about 500 miles. The air at sea level is subject to pressure due to the weight of air above it. Air at sea level is subject to a pressure of 14.7 pounds per square inch and has a density corresponding to that pressure.

The air at an altitude of one mile above sea level has a pressure of 12.1 pounds per square inch, and the pressure at a two-mile altitude is 9.9 pounds per square inch. The higher the altitude, the

lower the pressure and, consequently, the less the density. Altitude is an important factor affecting density, but it is not the only factor.

Another major factor affecting density is temperature. Charles' law states that the density of any gas will vary inversely with the temperature. As air becomes warm, it expands; and as it expands, it becomes thinner because there are fewer particles (molecules) per cubic foot. Therefore, on a warm day the air will be less dense than on a cold day. A definite relationship exists between density and helicopter flight efficiency.

Standard air is designated as air at 59° F. sea level conditions (29.92" Hg).

In general, the density of air will decrease, equivalent to 1,000 feet of altitude for each 15° rise in temperature. The presence of moisture in the air will also decrease density, as saturated moist air weighs approximately $\frac{5}{8}$ as much as pure, dry air. However, the presence of moisture in the average climate is not too significant.

Remember that wind is a great help in helicopter flight and may compensate for the loss of efficiency caused by density. The pilot should consider all the factors affecting operation, as each has a direct bearing on the performance of the helicopter. Only by careful analysis can the pilot obtain the maximum functional capacity from his helicopter.

REVIEW

The preceding material should have helped you gain a better understanding of helicopter flight. We discussed dissymmetry of lift, effects of resonance, weight limitations, blade stalls, and weather.

(Now answer the following review questions.)

10. On a single-rotor helicopter, a correction for dissymmetry of lift is to reduce the effective lift area of the advancing blades.

- A. True
- B. False

10.-A

This is done by incorporating a flapping hinge in the rotor head. (Refer to page 16)

11. The possibility of ground resonance is GREATEST during which helicopter condition?

- A. Takeoff
- B. Landing
- C. Hovering
- D. Taxing

11.-B

Ground resonance develops when one wheel of the main landing gear hits the ground and then the other wheel hits. The rocking motion will continue until some force breaks the beat. (Refer to page 16)

12. What will be the effect on a single-rotor helicopter if an excessive amount of weight is placed aft of the center of gravity?

- A. Aft cyclic range, will be insufficient to level the helicopter
- B. Forward cyclic range will be insufficient to level the helicopter
- C. Tail rotor control will be lost
- D. Main rotor control will be lost

12.-B

(Refer to page 18)

13. Under which flight conditions are helicopter blade stalls MOST likely to occur?

- A. High forward speed, low angle of attack, and low gross weights
- B. Excessive retreating blade speed and high gross weights
- C. High gross weights, high altitude, and high forward speed
- D. Low angle of attack and excessive retreating blade speed

13.-C

Blade stall is a loss of lift on the retreating blade. (Refer to pages 19 and 20)

14. Helicopter rotor blades will produce MORE lift on a _____ day.

- A. cool - dry
- B. hot - damp
- C. cool - damp
- D. hot - dry

14.-A

On a warm day, the air is thinner and the blades will produce less lift. (Refer to pages 20 and 21)

HH-3F GENERAL DESCRIPTION

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the dimensions of the HH-3F.
2. Identify the fuselage components, and state their locations.
3. Identify the various fuselage compartments and explain their use.
4. Describe the cabin equipment used in the HH-3F.

GENERAL

USCG model HH-3F helicopters (figure 26) are twin engine, search/rescue and cargo/personnel transport helicopters, designed and manufactured by Sikorsky Aircraft, Division of United Aircraft Corporation, Stratford, Connecticut. The crew consists of a pilot, copilot, flight mechanic, and avionicsman. The helicopters are capable of water landings and takeoffs and have auxiliary flotation for emergency landings. Distinguishing features include a hull-shaped fuselage, into which the nose gear retracts (kneels), and sponsons, into which the main landing gear retracts.

On HH-3F helicopters, two General Electric model T58-GE-5 gas turbine engines are used and mounted side-by-side above the fuselage forward of the main gear box. In addition to the engines, a fixed horizontal stabilizer is installed on the upper right side of the pylon, and an auxiliary power unit (APU) is mounted on the aft transmission deck. The APU is connected to the main gear box accessory drive and provides auxiliary power to run gear box accessories. Flight configuration is a five-blade main rotor and a five-blade tail rotor. Forward, aft, lateral, and vertical flight is accomplished through the main rotor, while the tail rotor counteracts torque from the main rotor and provides directional control. Power to drive the main rotor is supplied through the main gear box. The tail rotor is driven through shafting which extends aft from the main gear box, through the intermediate gear box, and terminates at the tail gear box.

Three separate hydraulic systems are used in the helicopter. The primary and

auxiliary hydraulic systems are used in conjunction with the mechanical linkage of the flight controls. The auxiliary hydraulic system is also used in conjunction with the automatic flight control system (AFCS). The utility hydraulic system provides power for the retractable main landing gear, nose landing gear, APU starting, ramp system, and rescue hoist.

Principal dimensions of the helicopter are shown in table 1 and figure 28. Weights of principal helicopter components are listed in table 2. Stations and waterlines provide an accurate method of locating or installing equipment in the airframe. Helicopter length is divided into stations, located one inch apart, beginning with station 42.5 at the nose of the helicopter. Station 21.7 is at the tip of the radome. Helicopter height is divided into waterlines, located one inch apart, beginning 106 inches below and parallel to the cabin floor. (See figure 27.)

FUSELAGE FORWARD SECTION

This section includes the electronics, battery, engine, and transmission compartments, main rotor fairing, engine and transmission service platforms, sponsons, and cockpit and cabin.

NOSE DOOR

The watertight nose door (figure 29) is in the nose of the lower fuselage. When the door is closed, a lock engages a funnel mouthed lock tube inside the electronics

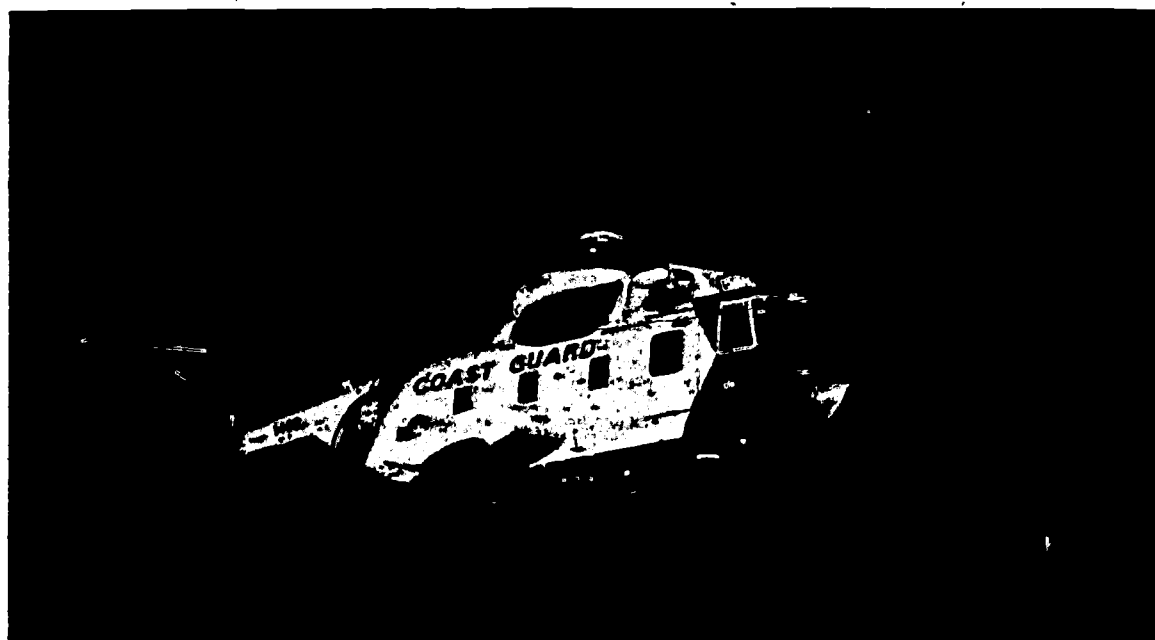


Figure 26. - Model HH-3F helicopter.

compartment. The lock tube, secured to the center overhead structure, is stowed up out of the way for access to the electronics compartment. A microswitch, attached to the lock tube, contacts the door. Opening the door causes the microswitch to actuate a warning light on the caution/advisory panel in the cockpit.

ELECTRONICS COMPARTMENT

The electronics compartment under the cockpit contains shelves of various depths and spacing to accommodate AFCS and navigation equipment. The compartment also contains flight controls, wheel brake compo-

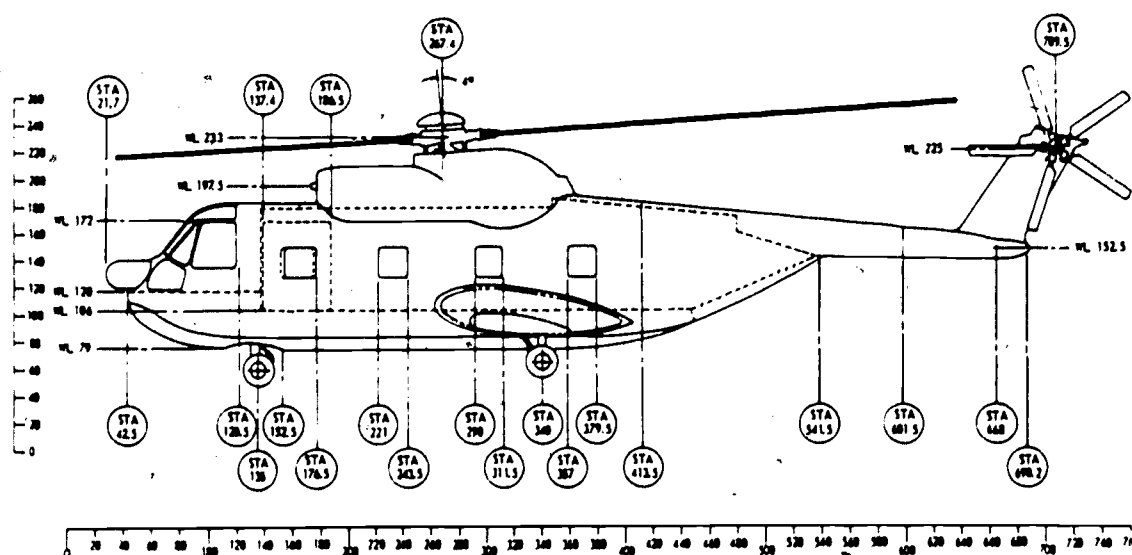


Figure 27. - Stations and waterlines.



Figure 28. - General arrangement

Table 1.- Principal Dimensions Table.

HELICOPTER DIMENSIONS		Blade Thickness	12% at 30% Chord
Length - Maximum (Blades at Extreme Position)	73 ft	Blade Twist	8 Degree LH
Length - Minimum (Blades Removed)	69 ft 1 in.	TAIL ROTOR BLADE DIMENSIONS	
Height - Maximum (Tail Rotor Blades at Extreme Position)	18 ft 1 in.	Tail Rotor Diameter	10 ft 4 in.
Width - Maximum	62 ft 0 in.	Tail Rotor Disc Area	83.9 sq ft
Width - Minimum (Blades Removed with Flotation Gear)	17 ft 8 in.	Individual Blade Area	2.35 sq ft
Main Rotor Ground Clearance - Minimum (Blades Station - Nosewheel Extended)	10 ft 1 in.	Number of Blades	5
Main Rotor Ground Clearance - Minimum (Blades Rotating - Nosewheel Kneeled)	10 ft 8 in.	Total Blade Area	11.75 sq ft
Main Rotor Ground Clearance - Minimum (Blades Station - Nosewheel Kneeled)	7 ft 4 in.	Solidity Ratio	0.189
Tail Rotor Ground Clearance - Minimum (Blades Rotating or Station)	7 ft 9 in.	Airfoil	NACA 0012
Tail Rotor Ground Clearance - Minimum (Blades Station or Rotating - Nosewheel Kneeled)	9 ft 11 in.	Blade Chord at Root	7.34 in.
Main Landing Gear Tread	13 ft 4 in.	Blade Chord at Tip	7.34 in.
Cabin Length	24 ft 8 in.	Blade Thickness	12% at 30% Chord
Cabin Width	6 ft 6 in.	Blade Twist	0 Degree
Cabin Height	6 ft 6 in.	STABILIZER DIMENSIONS	
MAIN ROTOR BLADE DIMENSIONS		Total Area	27 sq ft
Main Rotor Diameter	62 ft 0 in.	Taper Ratio	0.465
Main Rotor Disc Area	3019 sq ft	Total Angular Movement	0 Degree
Individual Blade Area	39.9 sq ft	Airfoil at Root (BL 0 to BL 11)	NACA 0015
Number of Blades	5	Airfoil at Tip (BL 11 to TIP)	NACA 0015
Total Blade Area	199.5 sq ft	Aspect Ratio	3.16
Solidity Ratio	0.07746	Number	1
Airfoil	NACA 0012	Span	6 ft 8 in.
Weight Each - Standard	207.80	Chord at Root	46.5 in.
Weight Each - De-icing Tape (Polyethylene)	208.80	Chord at Tip	21.1 in.
Blade Chord at Root	18.25 in.	Dihedral	3 Degree
Blade Chord at Tip	18.25 in.	HYDROSTATICS	
		Hull Buoyancy	28470 lb
		Sponson Buoyancy - Each	4797 lb
		Total Buoyancy	38064 lb
		Auxiliary Float Buoyancy - Each	3200 lb
		Draft - Empty Weight	14 in. at 11248 lb
		Draft - Normal Gross Weight	20 in. at 19500 lb
		Draft - Maximum Overload Gross Weight	22 in. at 22004 lb

Table 2.— Principal Components Weight Table.

COMPONENT	WEIGHT	EACH	COMPONENT	WEIGHT	EACH
Main Rotor Blade	207.8	lbs	Aft Ramp	175	lbs
Tail Rotor Blade	6.25	lbs	Demountable Power Plant (T58-GE-5)	440	lbs
Main Rotor Head	1000	lbs	Sponson (with Landing Gear)	260	lbs
Main Rotor Head (Titanium Plate)	985	lbs	Main Landing Gear	165	lbs
Swashplate	110	lbs	Main Wheel and Tire	20	lbs
Tail Rotor Head	90	lbs	Nose Landing Gear	140	lbs
Main Gear Box	1700	lbs	Auxiliary Power Unit (APU)	95	lbs
Main Gear Box QCU	3280	lbs	Heater (with Blower and Ignition Unit)	50	lbs
Intermediate Gear Box	40	lbs	Pylon (Assembled)	350	lbs
Tail Gear Box	76	lbs	Stabilizer and Strut	65	lbs
Oil Cooler and Blower	52	lbs	Rescue Hoist	49	lbs
Forward Ramp	165	lbs			

nents, emergency release cables, and other equipment necessary to operate and control the helicopter. Access is gained by opening the watertight nose door or by lifting out the access cover in the cockpit.

Battery Compartment

The battery compartment in the nose of the helicopter is a molded fiberglass shell containing battery shelf, mounting rods, clamps, and the battery quick-disconnect plug. The compartment is vented to prevent acid fumes from entering the cockpit. A rubber seal is incorporated on the outer flange of the battery compartment to ensure a watertight seal when the compartment door is closed.

Battery Compartment Door

The battery compartment door is on the nose of the helicopter. When closed, it renders the compartment watertight by

compressing a rubber door seal. The door is held in position by fasteners. A controllable spotlight is installed in the door.

ENGINE AND TRANSMISSION COMPARTMENT STRUCTURE AND FAIRINGS

The engine and transmission compartment structure (figure 30) and fairings include the firewalls, engine service platforms, rear engine cowlings, right and left transmission service platforms, forward engine cowling, right and left main rotor fairings, aft main rotor fairing, and when required, an engine inlet ice shield forward of the engine inlets. The fairings reduce air turbulence and prevent moisture and dirt from entering the area. The engine inlet ice shield prevents foreign objects from entering the engine inlets.

Engine Service Platforms

An engine service platform (figure 29), outboard of each engine, provides a work

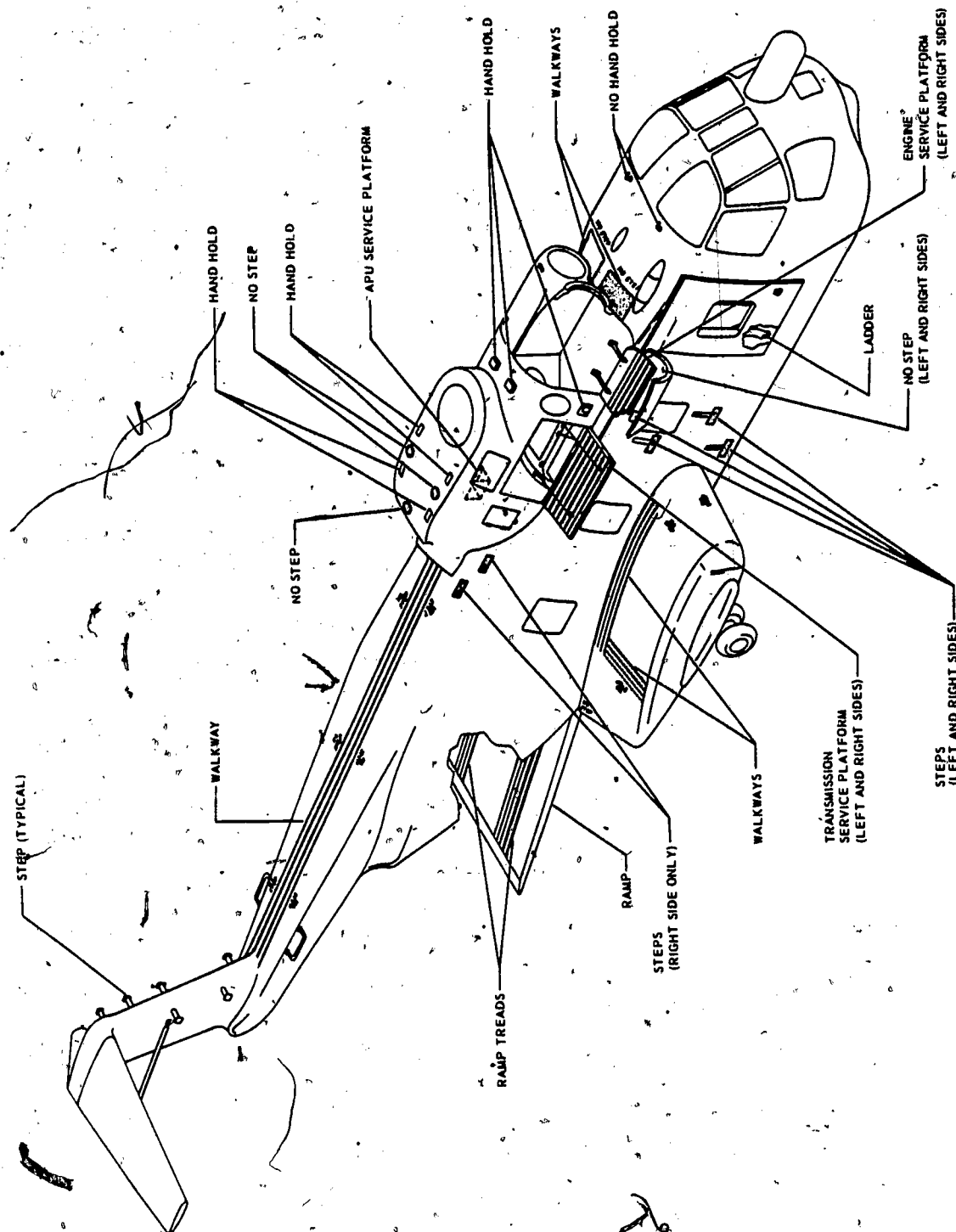
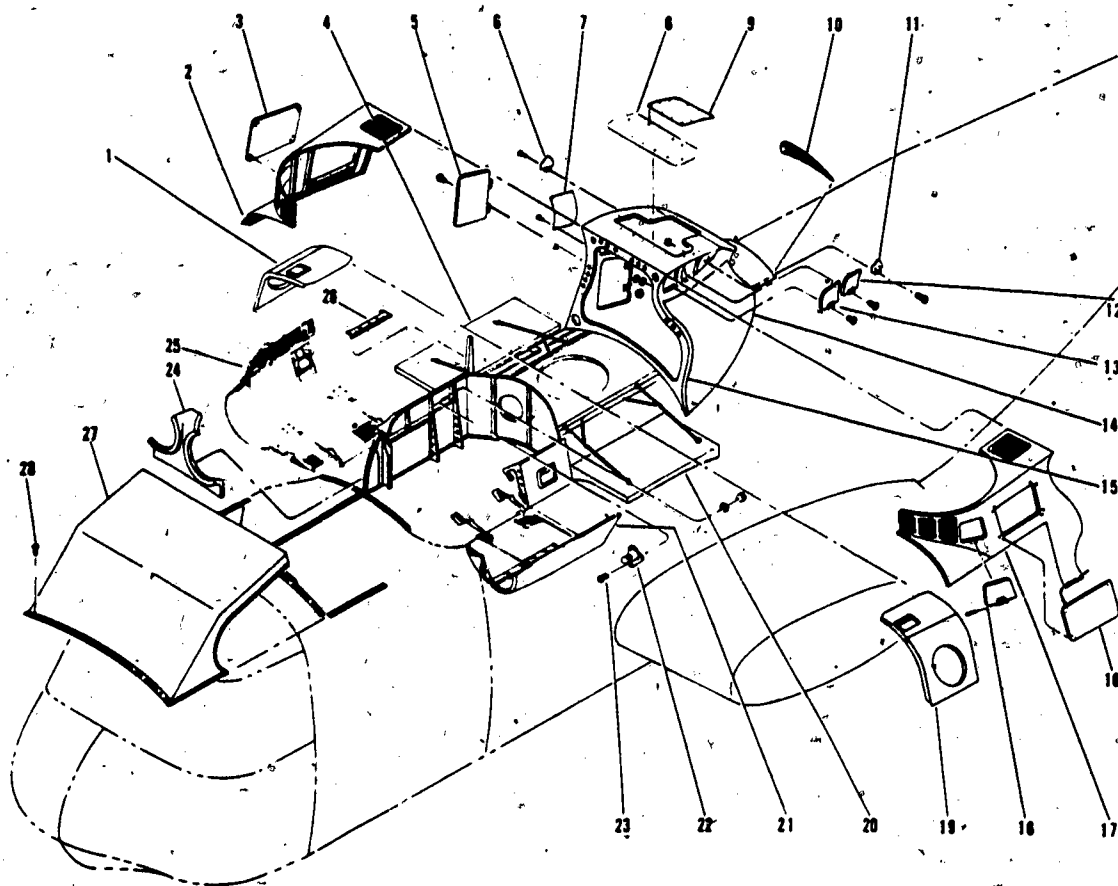


Figure 29. - Steps and walkways.

area with a capacity of two men each. Hinges and links support each platform when in the open position. The latch and handle mechanisms and part of the fire detection system are on the platform. When the platforms are in the closed position, they form the fuselage surface over the engine compartments.

Engine Compartments

The engine compartments (figure 30), above and slightly aft of the cockpit, are formed by the center firewall, a canted firewall, engine service platforms (in the



- | | | |
|-------------------------------------|-------------------------------------|----------------------------------|
| 1 No. 2 Engine Aft Cowling | 11 Inspection Door | 21 No. 1 Engine Service Platform |
| 2 Right Section, Main Rotor Fairing | 12 Access Door | 22 Fitting |
| 3 Access Panel | 13 Access Door | 23 Bolt, Washer, Nut |
| 4 Transmission Service Platform | 14 APU Cowling | 24 Forward Engine Cowling |
| 5 Access Door | 15 Aft Structure | 25 No. 2 Engine Service Platform |
| 6 Inspection Door | 16 Access Panel | 26 Channel |
| 7 Access Door | 17 Left Section, Main Rotor Fairing | 27 Engine Inlet Ice Shield |
| 8 Access Panel | 18 Access Door | 28 Screw |
| 9 Access Panel | 19 No. 1 Engine Aft Cowling | |
| 10 Screen | 20 Transmission Service Platform | |

Figure 30. - Engine and transmission compartment structure and fairing.

closed position), and an aft engine cowling. The canted firewall separates the two engine compartments from the transmission compartment. The center firewall separates the two engine compartments from each other and contains one large opening fitted with a removable cover. The opening permits access to disconnect plugs, throttle linkage, and the power turbine tachometer-generator of the No. 2 engine. In each engine compartment, overboard drain lines are incorporated for fuel, lubrication, and water condensa-

tion. Access to the engine compartments is gained by hinging down the engine service platforms and removing the aft engine cowlings.

Engine Cowlings

The aft engine cowling (figure 30, items 1 and 19) is a heat-resistant removable covering made of titanium. The forward

engine cowling is a removable covering made of fiberglass. The aft engine cowling is removed for engine maintenance. The forward engine cowling ("T" cowl) can be removed only when the engine inlet ice shield is removed. The cowlings are secured by fasteners.

Firewalls

A center firewall (figure 30), separates the engine compartments, and a canted firewall separates each engine compartment from the transmission compartment. Fabricated of heat-resistant titanium, they also act as supports for the cowlings and engine service platforms. The firewall, separating the engine compartments, has an opening fitted with a removable titanium cover. The opening permits access to disconnect plugs, throttle linkage, and power turbine tachometer-generator on the No. 2 engine. The canted firewalls incorporate special seals encircling the engine shaft support to prevent fire seeping through the firewalls.

Transmission service platforms

A transmission service platform (figure 30 item 4), below and outboard on both sides of the main gear box, provides a work area with a capacity of two men each. Each transmission service platform has a securing mechanism and is supported by cord and cable assemblies. The securing mechanism consists of a thumb latch, spring-loaded handle, tube, and latches. When the platforms are in the closed position, they form part of the main rotor fairing.

Main Rotor Fairing

The main rotor fairing (figure 30, items 2 and 17) protects transmission compartment components from weather and foreign matter. Its configuration is designed to reduce air turbulence. Housed within the fairing are the main gear box, primary hydraulic system pressure transmitter, generators, lateral and fore-and-aft servocylinders and the primary, auxiliary, and utility hydraulic system pumps and associated valves, tubing, and connectors. The transmission service platforms and the two access

panels allow limited maintenance operations within the transmission compartment. For such operations as removing the main gear box, the complete main rotor fairing must be removed.

Aft Main Rotor Fairing

The aft main rotor fairing (figure 30, item 15) serves as a protective housing against weather and foreign matter for the main gear box oil cooler, primary, auxiliary, and utility reservoirs, utility and auxiliary pressure transmitters, fire extinguisher bottles, and associated valves, tubing, connectors, and wiring housed within the fairing. A group of access panels permits servicing, repairs, or replacement within the aft main rotor fairing. Streamline configuration of the fairing reduces air turbulence.

Auxiliary Power Unit (APU) Service Platform

An APU service platform (figure 29), below and outboard of the APU, provides a work area with one man capacity. The platform latches at the top and has two hinges at the bottom. When unlatched and lowered for use, the platform is supported by two cables. When closed, the platform forms a flush fitting contour with the helicopter fuselage. The APU service platform may be removed by disconnecting cables and removing hinge pins.

Transmission Compartment

The transmission compartment, aft of the engine compartment, houses the main gear box and other components and electrical units. The main rotor fairings protect these components from weather and foreign matter. Access to the transmission compartment is gained from the right or left transmission service platform and from the cabin when the main gear box drip pan is removed.

Engine Inlet Ice Shield

Provisions exist for mounting an engine inlet ice shield (figure 30, item 27) forward of the engine inlets to prevent objects

from being ingested into the engines. The ice shield consists of a plastic skin bonded to an aluminum angle frame, which is screwed to the fuselage.

SPONSON

Watertight sponsons (figure 31, item I), on both sides of the helicopter, support the main landing gear and provide stability to the helicopter while in the water. On the outboard side of each sponson is an auxiliary flotation bag, and in the left-hand sponson are two auxiliary flotation air cylinders. Each sponson has drains and access covers for draining and inspection of bilges and fairings for servicing the main landing gear and hover lights. The auxiliary flotation system is actuated manually inside the cabin and from overhead the copilot's seat.

bottom structure contains the electronics compartment, fuel cells, fuel selector valves, and interconnecting fuel lines. Fiberglass liners are provided to protect fuel cells from damage. The bottom structure skeleton is covered with plating which is sealed and riveted to form a watertight unit.

CABIN FLOORING

The floor surfaces include removable floor panels. All flooring is constructed of two aluminum sheets with honeycomb core. Circular access covers are mounted over the fuel cells. Other access covers and panels are provided for components below the cabin flooring.

FUEL CELL LINERS

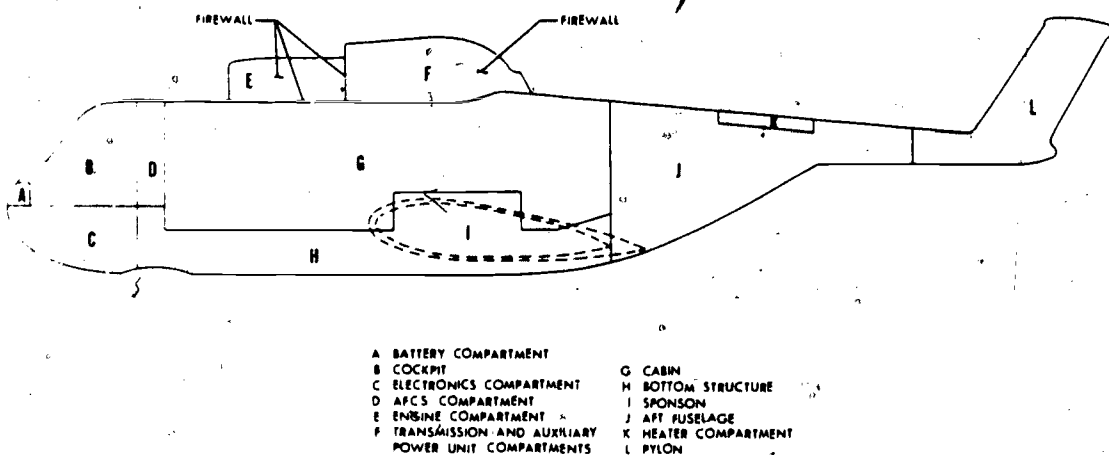


Figure 31. - Fuselage compartments.

FLIGHT CONTROLS COMPARTMENT

The flight controls compartment (figure 31), aft of the pilot's seat in the forward portion of the cabin, houses part of the flight controls system, the auxiliary servo-cylinder, mixer unit, and mechanical linkage. Access to the compartment is gained through a door on the cabin side of the compartment.

BOTTOM STRUCTURE

The bottom structure extends the length of the fuselage, ending at the ramp. The

Fiberglass fuel cell liners prevent the fuel cells from chafing on the helicopter structure. Each cell is protected on the bottom by two preformed liners which fit the contour of the helicopter bottom structure. In addition, a liner is secured to the aft side of the bulkhead, dividing the forward fuel cells, and another liner is secured to the forward side of the bulkhead, dividing the aft fuel cells.

FUSELAGE AFT SECTION

The fuselage aft section (figure 31, item J) serves to extend the airframe and

support the pylon. The pylon is joined to the aft section and is removable.

PYLON

The pylon (figure 31, item L) supports the intermediate gear box, section IX of the tail drive shaft, tail gear box, tail rotor and associated controls, position and rotating beacon anti-collision lights, and the stabilizer. It is secured to the fuselage aft section. The trailing edge is streamlined by removable fairings which house the intermediate gear box, section IX of the tail drive shaft, and the tail rotor control system. The top is covered by a removable fiberglass fairing, which houses the tail gear box and supports the rotating beacon anti-collision light. Four retractable steps are on the left side and two on the right side. The step may be extended by pushing in, turning counterclockwise, and pulling outward. A spring holds the step in

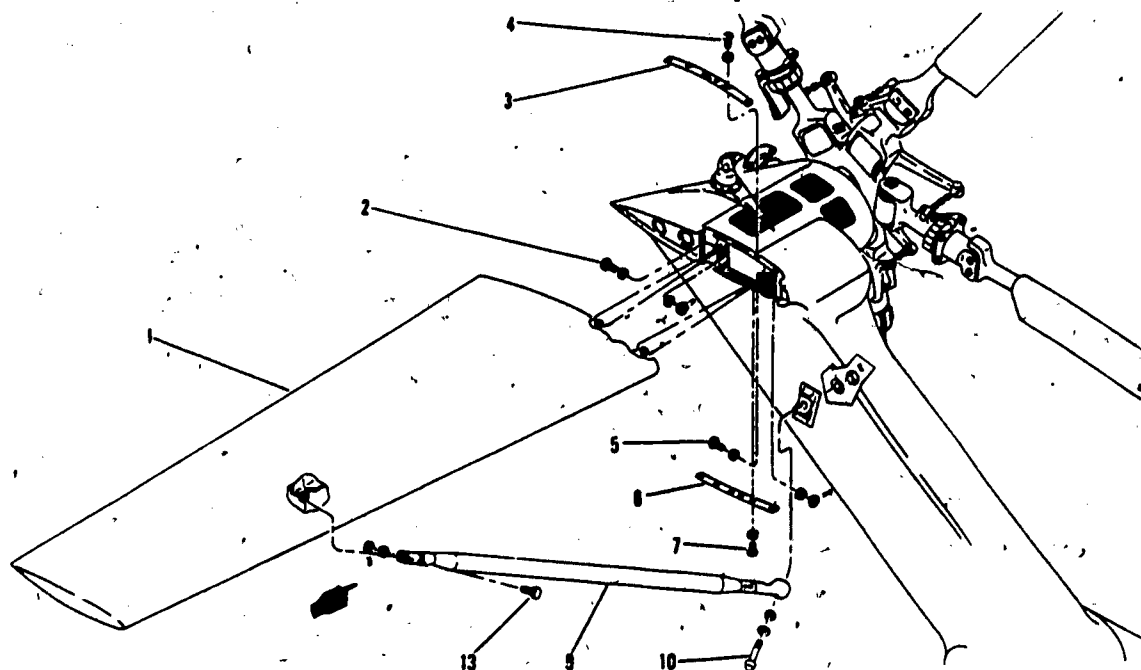
the extended position. When retracted, the step is held in position by a pin which is turned into a locking slot.

STABILIZER AND STRUT

The stabilizer (figure 32, item 1), installed on the pylon, is a fixed, horizontal airfoil which provides longitudinal stability. It is composed of ribs, bracket, angles, beams, aluminum alloy skin, and a fiberglass tip. It is bolted to and supported vertically by the strut and bolted at fittings at the root end and upper pylon.

CABIN EQUIPMENT

The cabin (figure 34) located from station 137.0 to station 379.5 is capable of carrying cargo, personnel, litters, and



- 1 Stabilizer
- 2 Bolt, Washers, Nut, Cotter Pin
- 3 Cover Plate
- 4 Screw Washer

- 5 Bolt, Washers, Nut, Cotter Pin
- 6 Cover Plate
- 7 Screw, Washer
- 8 Deleted

- 9 Strut
- 10 Bolt, Washer, Ball Seat, Washer, Nut, Cotter Pin
- 11 Deleted
- 12 Deleted

- 13 Bolt, Washer, Nut, Cotter Pin
- 14 Deleted
- 15 Deleted
- 16 Deleted

Figure 32. - Stabilizer.

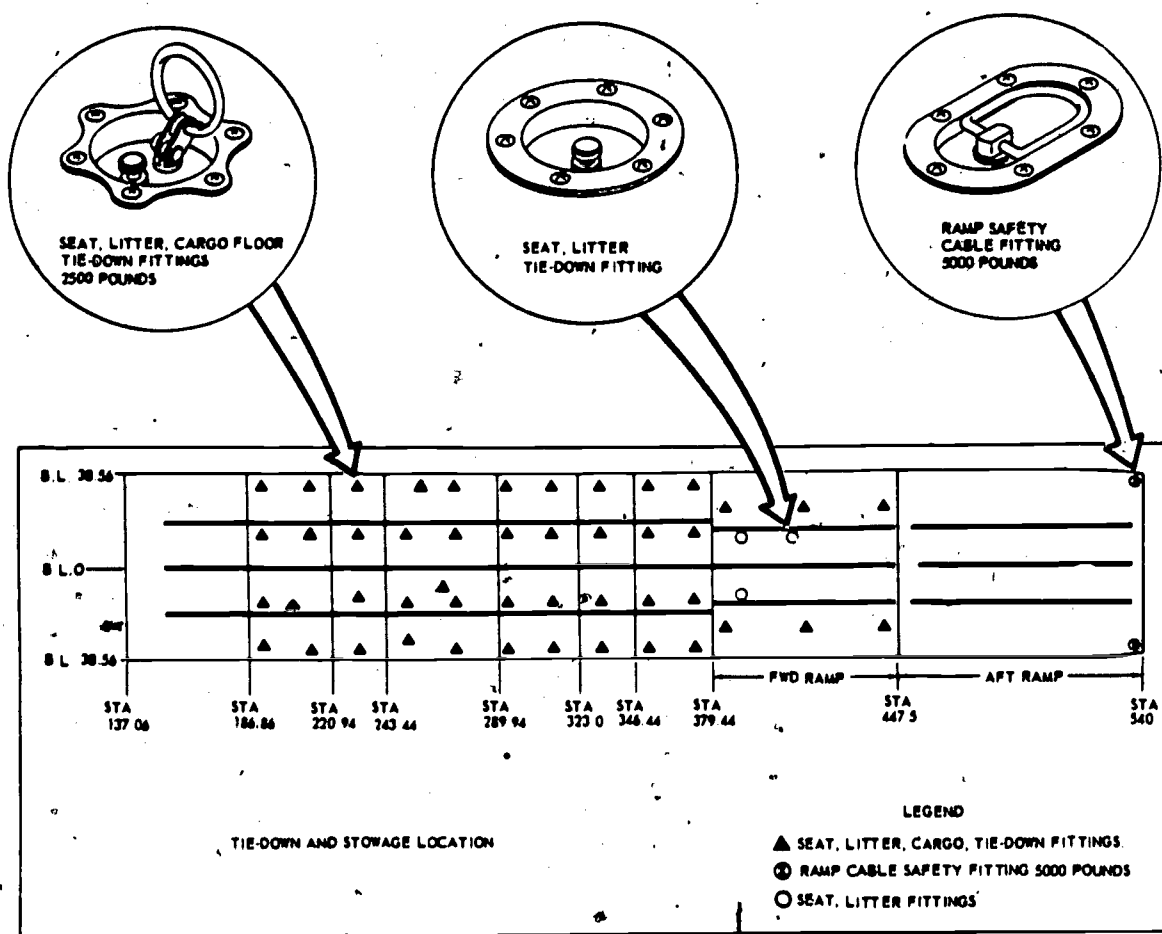


Figure 33. - Tiedown fittings, location.

wheeled vehicles. The impact and wear-resistant cabin floor has a positive non-skid surface for personnel footing, and skid strips to facilitate the movement of cargo and provide floor protection. The cabin floor is divided into six sections and capable of sustaining static loads of 200 pounds per square foot. Tiedown fittings, rated at 2,500 pounds, are installed on the cabin floor to facilitate cargo tiedown, and are provided with fittings that serve as troop-seat and litter attachment points. The cabin contains a personnel door and a ramp, both of which may be used for loading personnel and cargo. When loading the helicopter, refer to T.O. 1-1B-40, Handbook of Weight and Balance Data.

CARGO LOADING STATIONS

The cabin is divided into marked cg stations between fuselage stations 150 and

375. Cargo loading scales, corresponding to these marked stations, are provided on the load adjuster. The cg loading stations are marked at eye level for easy reference.

CABIN FLOOR

The cabin floor, made up of 1-inch-thick honeycomb floor panels, is supported by transverse bulkheads and beams. The cabin floor is approximately 310.5 inches long and 76 inches wide. The forward ramp forms the last 68 inches of horizontal floor. The floor has a positive non-skid surface. Three rows of low friction longitudinal skid strips are installed on top of the cabin floor to provide floor protection and facilitate cargo handling. The cabin floor area is designed to support a maximum load of 200 pounds per square foot; however,

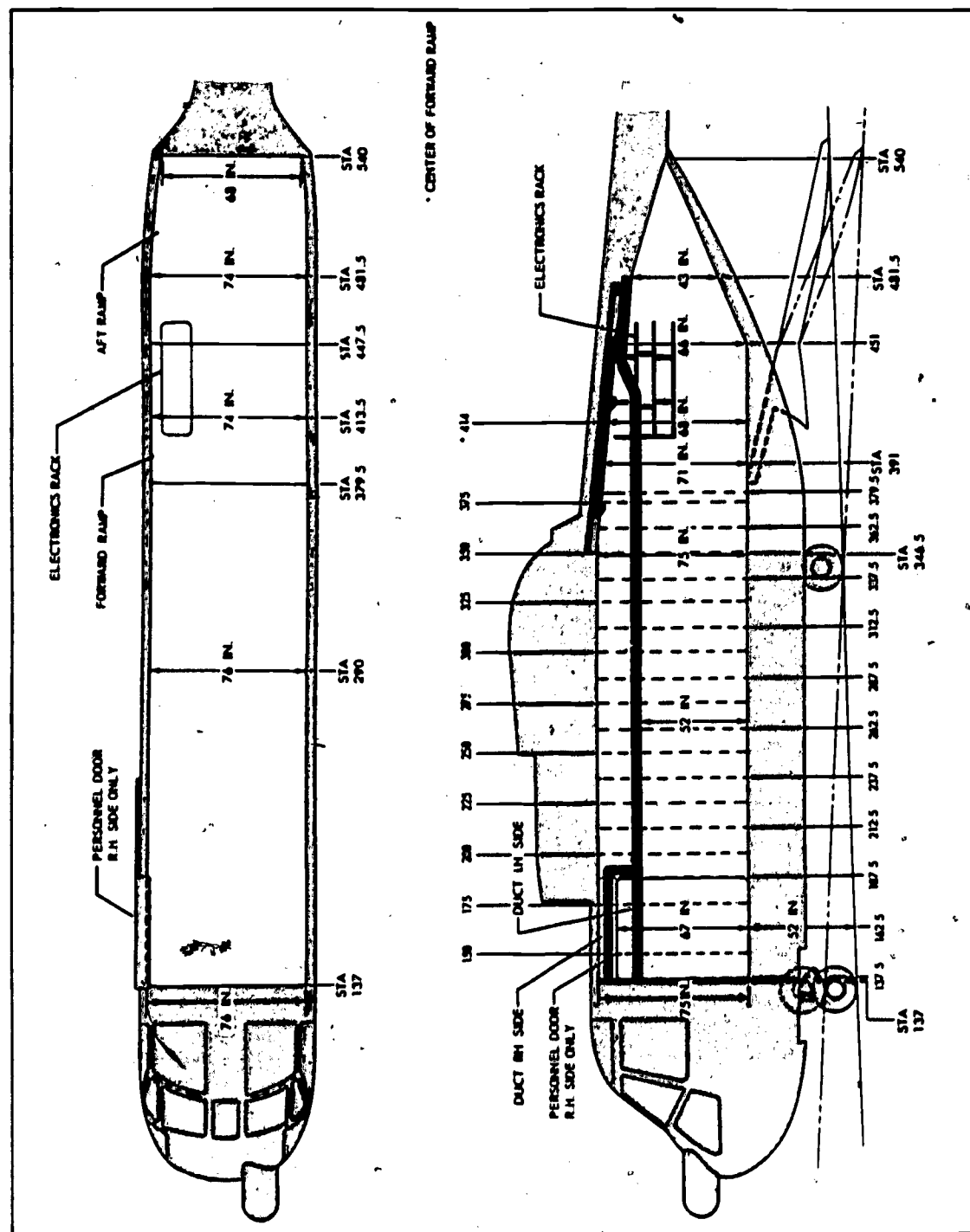


Figure 34. - Cabin.

higher weights may be carried if shoring is used to distribute the weight over a larger area.

TIEDOWN FITTINGS

The type of tiedown fitting (figure 33) used is the combination cargo restraint and lug for troop seat and litter floor attachments. The recessed tiedown fittings have a 2,500-pound restraint capability. The 2,500-pound tiedown fittings are used

to secure cargo, litter support straps, troop seat legs, and the crewman's safety harness.

TIEDOWN DEVICES

Various types of tiedown devices may be used for securing cargo. One type is a turnbuckle arrangement for tightening the tiedown chains; another is a webbed type strap with hooks for attaching to tiedown fittings.

REVIEW

In this section, the description of the HH-3F helicopter will help you in completing preflights, postflights, and successful SAR missions.

(Now answer the following review questions.)

15. What are some of the features of the HH-3F helicopter?

1. Retractable nose landing gear
2. five-blade tail rotor
3. A utility hydraulic system used to provide power for an automatic flight control system
4. An auxiliary power unit for driving the gear box accessories
5. Three separate hydraulic systems

- A. 1, 2, and 3 only
- B. 3, 4, and 5 only
- C. 1, 2, 4, and 5
- D. 1, 2, 3, and 4

15.-C The utility system supplies hydraulic power to the ramp, hoist, and landing gear.
(Refer to page 25)

16. What is the minimum tail rotor ground clearance when the blades are rotating?

- A. 6 ft. 3 in.
- B. 6 ft. 6 in.
- C. 7 ft. 4 in.
- D. 7 ft. 9 in.

16.-D (Refer to page 29)

17. Access to the electronics compartment is gained by _____.

- A. going through the deck opening in the cabin
- B. removing the plate on the fuselage
- C. opening the nose door
- D. walking aft in the cabin

17.-C (Refer to page 25)

18. Damage has occurred to the forward engine cowlings of an HH-3F helicopter. To remove this piece of cowlings for repair, what else must you remove?

- A. Main rotor cowlings
- B. Aft engine cowlings
- C. Engine inlet ice shield
- D. Number one engine

18.-C (Refer to page 33)

19. The right-hand sponson is equipped with which of the following?

1. Drain ports
2. Hover light
3. Bilge access covers
4. Auxiliary flotation air cylinders

- A. 2 and 4 only
- B. 3 and 4 only
- C. 1, 2, and 3 only
- D. 1, 2, 3, and 4

20. How is the auxiliary flotation system actuated?

- A. Manually
- B. Electrically
- C. Hydraulically
- D. Electromechanically

21. The fuel cells are prevented from chafing on the helicopter structure by _____ fuel cell liners.

- A. rubber
- B. fiberglass
- C. plastic
- D. Bakelite

22. The cabin floor is designed to sustain static loads of _____ pounds per square foot.

- A. 200
- B. 400
- C. 2,000
- D. 2,500

19.-C The auxiliary flotation air cylinders are in the left-hand sponson. (Refer to page 34)

20.-A The handles in the cabin overhead are actuated. (Refer to page 34)

21.-B (Refer to page 34)

22.-A (Refer to page 36)

ELECTRICAL POWER

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the HH-3F electrical supply systems, AC and DC.
2. Identify the AC power supply system components and explain their use.
3. Identify the DC power supply system components and explain their use.
4. Summarize the external power supply system.
5. Identify the lighting equipment used on the HH-3F and explain its use.

ELECTRICAL POWER SUPPLY SYSTEM

Two brushless generators supply 115/200 volt, three phase, 400-Hertz AC power to the electrical system. Three transformers provide 26-volt single-phase AC power. Both generators also supply 28-volt DC power to the electrical system control circuits. Two converters provide 28-volt DC control and operating power. One battery supplies 24-volt DC power.

ALTERNATING CURRENT POWER SUPPLY SYSTEM

AC power is supplied by two generators designated as No. 1 and No. 2. Associated system components are designated in a similar manner. System operation is automatic; control switches on the overhead switch panel and monitoring caution-advisory light capsules on the caution-advisory panel are provided. Normally, associated primary and monitored bus loads are assumed by each generator. Primary bus loads are those that are essential for night instrument flight, and monitor bus loads are not essential for this type of flight. If either generator fails, its primary bus load is automatically transferred to the remaining generator. With a failed generator, all monitor bus loads are automatically dropped. An AC external power receptacle permits use of an AC external power unit for ground power application.

Generators

Two 115/200-volt, 3-phase, 400-Hertz, PMG, AC generators are mounted on and are driven by the accessory section of the main gear box. Generator output varies with temperature and altitude (approximately 20 KVA at sea level to 25 KVA at 15,000 feet altitude). Generator AC voltage is delivered to the associated supervisory panel and generator contactor relay. The permanent magnet sections of the generators also develop DC power to be used in the control circuits. This DC power is delivered to the associated supervisory panel. The auxiliary power unit (APU) drives the generators through the main gear box accessory section when the rotor rpm is below 100% N_r . When the rotor speed reaches 100% N_r , the accessory section is driven through the main gear box.

Supervisory Panels

The supervisory panels designated No. 1 and No. 2 provide control for all AC relays and one DC relay in the electrical system. When the No. 1 generator is developing normal AC power and the generator switch is placed ON, DC power from the same generator will be used by the No. 1 supervisory panel to close the No. 1 generator contactor relay. Closing the No. 1 generator contactor relay permits the No. 1 generator to power

the No. 1 AC primary bus and to deliver 28 volts DC to the AC monitor bus relay. In addition, closing the relay opens the No. 1 generator caution light circuit, causing the light to go out. The No. 2 supervisory panel operates the same way to power the No. 2 AC primary bus and to turn out the No. 2 caution light. DC power from the No. 2 supervisory panel also closes the AC monitor bus control relay, and the No. 1 and No. 2 monitor bus contactor relays. Therefore, 28-volt DC power is required from both the No. 1 and No. 2 supervisory panels to energize the AC and DC monitor buses. If either generator fails to produce 28 volts DC, the primary DC bus supplies backup DC voltage to each supervisory panel through circuit breakers. The circuit breakers, located on the overhead circuit breaker panel, are marked 1 and 2 under the general heading PMG BACKUP.

The supervisory panels provide protection for the electrical system. AC power delivered to the panel from its associated generator is monitored by the panel for open phase, overvoltage, and undervoltage at all times. The panel monitors for underfrequency when the helicopter is on the ground with its main landing gear struts compressed, activating the scissors switch. If any of the monitored conditions are not normal, the generator contactor relay will open, taking the associated generator off the line, de-energizing all monitor buses, and illuminating the associated generator caution light. If the generator fails, primary AC bus loads will be switched automatically to the remaining generator.

Generator Switches

The generator switches are located on the overhead switch panel (figure 37) under the general heading 1 GEN 2 and have the marked positions ON-OFF RESET-TEST. Placing the switch on the ON position puts the respective generator on the line by closing the generator contactor relay. The OFF-RESET position turns the generator off and resets the cycle. The TEST position is used only for maintenance.

Generator Caution Lights

Two generator caution lights, marked #1 GEN and #2 GEN respectively, are located on the caution-advisory panel. These lights

will illuminate whenever the associated generator is taken off the line by opening the generator contactor relay, which causes the caution light circuit to be completed. The generator caution lights are powered by the DC primary bus and are protected by circuit breakers on the overhead circuit breaker panel. The circuit breakers are marked No. 1 and No. 2 under the general headings GENERATOR and INDICATOR LTS.

Autotransformers

Three autotransformers in the AC system convert 115-volt power from the primary AC buses to 26 volts. Two of the autotransformers are powered by the No. 1 primary bus and are protected by circuit breakers in the copilot's overhead circuit breaker panel. The circuit breakers are marked 26V XMFR and RADIO XMFR 26V 0B under the general heading No. 1 AC PRI. The autotransformer protected by the circuit breaker marked 26V XMFR supplies 26 volts AC to the copilot's AN/ASN-50 compass, copilot's ID-250 RMI card, primary hydraulic pressure gage, transmission oil pressure gage, and the No. 1 engine torque sensor and oil pressure gages. The autotransformer protected by the circuit breaker marked RADIO XMFR 26V 0B supplies 26 volts AC to the pilot's AN/ASN-50 compass, pilot's ID-250 RMI card, both pilot's ID-250 pointers, AN/AYN-1, AN/APN-175, AN/ARN-73, AN/ARN-87 (NVA-22A), AN/ARN-52(V) and AN/ARA-25. The third autotransformer is powered by the No. 2 primary bus and is protected by a circuit breaker on the pilot's overhead circuit breaker panel (figure 35). The circuit breaker is marked 26V XMFR under the general heading No. 2 AC PRI. This autotransformer supplies 26 volts AC to operate the primary and utility hydraulic pressure gages and the No. 2 engine oil pressure and torque sensor gages.

AC Utility Power Receptacles

Two 115-volt AC 400 Hertz utility receptacles are provided. The receptacles receive power from the No. 1 AC monitor bus through two circuit breakers on the copilot's overhead circuit breaker panel. The circuit breakers are marked CABIN and XMSN under the general headings UT RECP and NO. 1 AC MON.

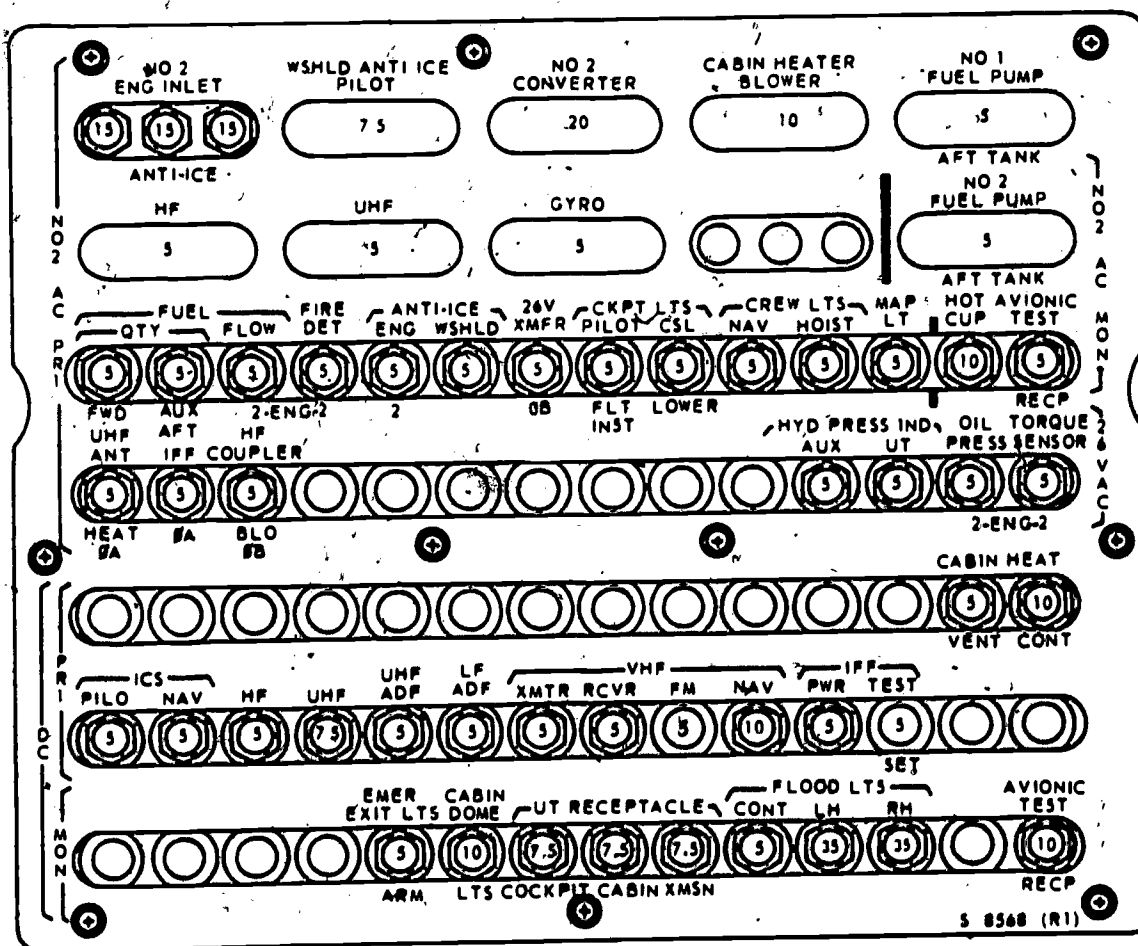


Figure 35. - Pilot's overhead circuit breaker panel.

Alternating Current Circuit Breakers

Alternating current circuit breakers are located on the pilot's and copilot's overhead circuit breaker panels (figures 35 and 36).

DIRECT CURRENT POWER SUPPLY SYSTEM

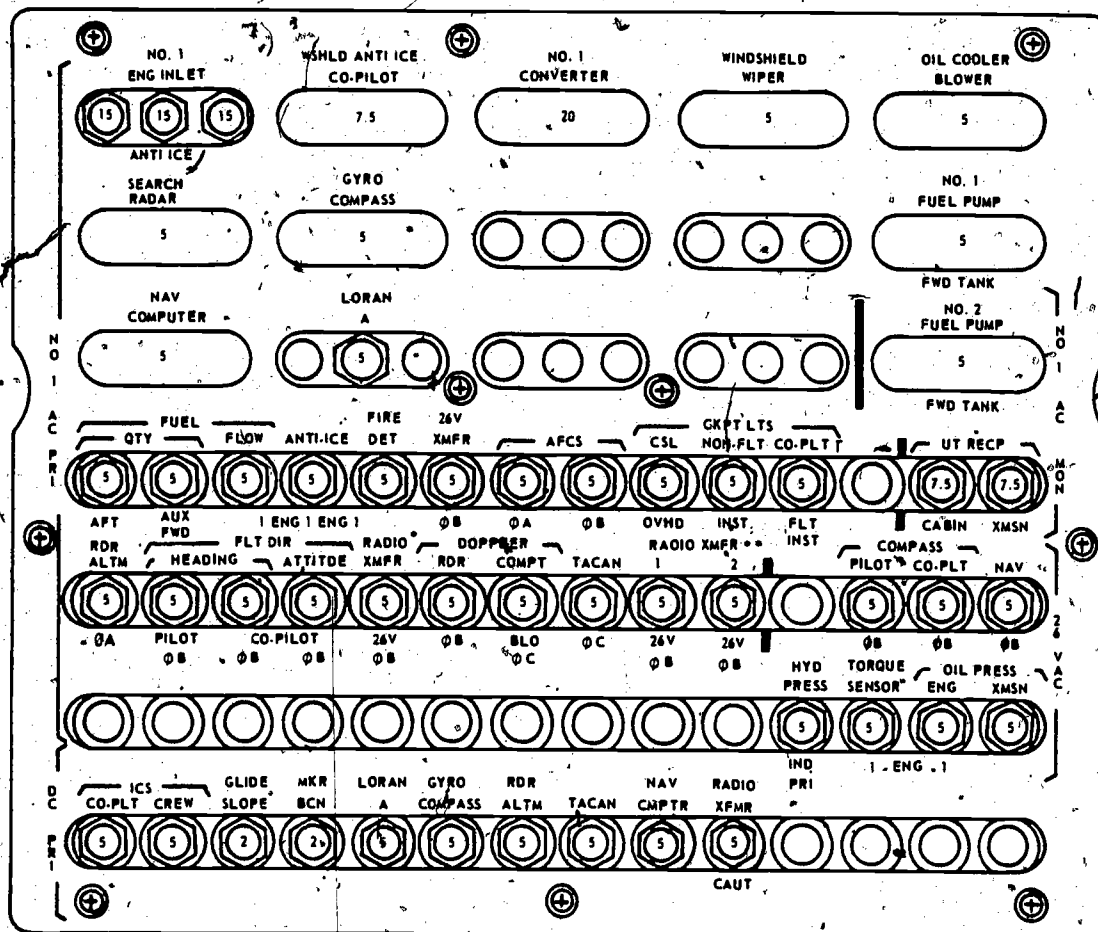
DC power is supplied by two 28-volt, 200-ampere converters, designated as No. 1 and No. 2, which are powered by the No. 1 and No. 2 AC primary buses respectively. The DC system operation is automatic; control switches and converter caution lights are provided. Normally, primary and monitor bus loads are assumed by both converters. Primary bus loads are those loads essential

for flight under night instrument conditions whereas monitor bus loads are those not essential for this type of flight. If one converter fails, the associated reverse current cutout relay will remove the failed converter from the DC primary bus. The remaining converter will assume the DC primary bus loads, and the DC monitored bus loads will be dropped. The battery can provide power to the DC primary bus when no other source is available. The DC external power receptacle and associated circuitry permit use of an external power unit for ground power application.

Converters

Two 200-ampere, 28-volt DC converters are located in the electronics compartment. The converters require an AC input from

COPILOT'S



* HELICOPTERS NOT MODIFIED BY T.C.T.O. 1H-3(H)F-536 AND PRIOR TO CG 1487.
 ** HELICOPTERS MODIFIED BY T.C.T.O. 1H-3(H)F-536 AND CG 1487 AND SUBSEQUENT.

Figure 36. - Copilot's overhead circuit breaker panel.

the generators or from an AC external power source. The two converters are designated as No. 1 and No. 2, and the associated components are designated in a similar manner. Both converters normally supply power to the DC primary bus. The DC primary bus supplies power to the DC monitor bus. The No. 1 converter receives three-phase power from the No. 1 AC primary bus, and the No. 2 converter receives three-phase power from the No. 2 AC primary bus. The AC input is stepped down, rectified, and filtered within each converter, and the DC output is fed to the associated reverse current cutout relay. During normal operation, DC power from the reverse current cutout relay is fed to the DC primary bus. If either conver-

ter or either AC generator fails, the monitor bus is automatically dropped from the line, and an appropriate caution light will illuminate. The reverse current cutout relay prevents current flow from the DC primary bus to a failed converter. The DC monitor bus will be dropped from the line if the AC monitor bus relay is open. The DC monitor bus relay must be closed for the monitor bus to receive power. Power to close this relay comes from the DC primary bus and is routed through the No. 2 and the No. 1 reverse current cutout relays. If either converter, either reverse current cutout relay, or either AC generator is inoperative (or if either converter switch is OFF), the DC monitor bus will be dropped from

the line. The No. 1 converter is protected by a circuit breaker on the copilot's overhead circuit breaker panel (figure 36). The circuit breaker is marked No. 1 CONVERTER under the general heading No. 1 AC PRI. The No. 2 converter is protected by a circuit breaker on the pilot's overhead circuit breaker panel. The circuit breaker is marked No. 2 CONVERTER under the general heading NO. 2 AC PRI.

Converter Switches

The converter switches are located on the overhead switch panel under the general heading 1 CONVERTER 2 and marked ON and OFF.

Converter Caution Lights

Two converter caution lights, marked #1 CONV and #2 CONV, are located on the caution-advisory panel. Failure of a converter, or reverse current cutout relay (or turning a converter switch OFF) will illuminate the associated caution light.

Battery

A 24-volt, 22-ampere hour nickel cadmium battery, located in the nose section forward of the pilot's compartment, is accessible from outside the helicopter. Battery power is used for limited ground operations, when no external power is available, and as an emergency source of power to the DC primary bus. The battery bus is continually energized and provides power for the anchor lights. The battery bus is connected to the DC primary bus when the battery switch is ON.

BATTERY OVERTEMPERATURE WARNING SYSTEM

When a battery temperature of 135° (±5°)F is detected by the battery over-temperature sensing unit, a BAT OVTEMP light on the caution panel will illuminate. At this time, the battery must be removed from its charging source by placing the battery switch OFF. The BAT OVTEMP caution light will go out when the battery cools to about 95°F or when all power is turned off. The caution light is powered by the dc primary bus.

Battery Switch

The battery switch (figure 37), located on the overhead switch panel, is labeled BATTERY, with positions marked ON and OFF.

DC Utility Power Receptacle

Three 28-volt DC utility receptacles are installed. The receptacles receive power from the DC monitor bus through three circuit breakers on the pilot's overhead circuit breaker panel. The circuit breakers are marked COCKPIT, CABIN, and XMSN under the general headings UT RECEPTACLE, MON, and DC.

Direct Current Circuit Breakers

Direct current circuit breakers are located on all three overhead circuit breaker panels and on the battery bus circuit breaker panel.

EXTERNAL POWER

External Power Switch

The external power switch is located on the overhead switch panel under the heading EXT PWR with positions marked ON and OFF. The external power switch is protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked EXT PWR under the general heading DC PRI BUS.

External Power Advisory Light

The external power advisory light, located on the caution-advisory panel and marked EXT POWER, will illuminate when the external power switch is ON and external power is being supplied to the aircraft.

AC External Power Receptacle

The AC external power receptacle is located on the left side of the fuselage aft of the sponson, and is used to connect 115/200-volt, 3-phase, 400-Hertz power to the helicopter. A phase sequence relay is incorporated to sense proper external power phase rotation. If external AC power is connected to the receptacle and the phase rotation is incorrect, power will not be applied to the electrical system. However, if the phase rotation is correct, DC power will pass through the phase sequence relay and close the external power contactor re-

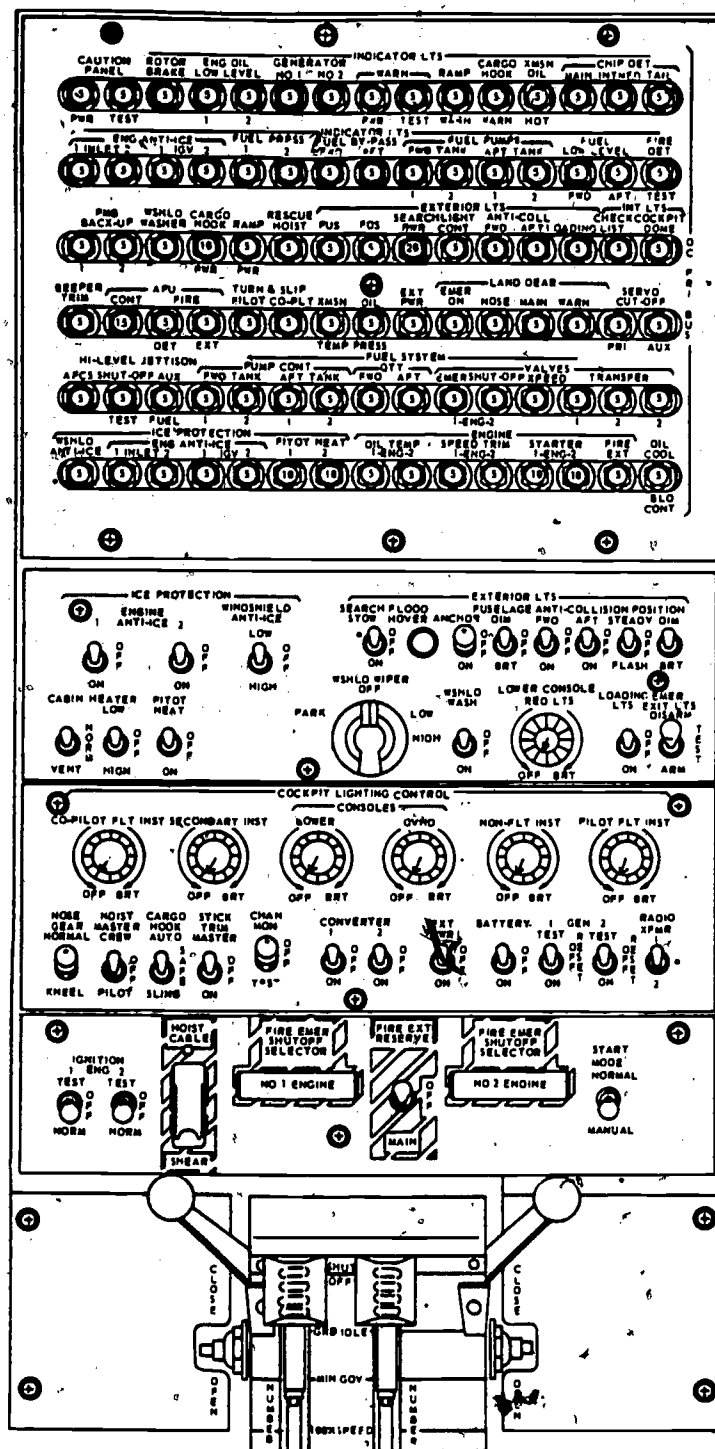


Figure 37. - Overhead control and circuit breaker panels.

lay, thus admitting external 3-phase power into the AC electrical system.

Two different type external power units may be used to provide AC external power.

One type provides AC power only, and the other provides AC power and 28-volt DC control power to the phase sequence relay. When external power units providing AC power only are plugged into the helicopter, power is delivered through the phase sequence relay to the external power contactor. In this configuration, the battery switch and the external power switch must both be ON. The battery switch must be ON to power the DC primary bus, and the external power switch must be ON to permit the DC primary bus to supply control power to the phase sequence relay. If AC phase rotation is correct, DC control power will pass through the phase sequence relay to illuminate the external power advisory light, and close the external power contactor relay and both AC monitor bus contactor relays. Closing these relays will allow the AC power system to function normally. With the converter switches ON, the DC monitor bus control relay and the DC monitor bus relay will close, and the DC power system will function normally. If external power is to be used for an extended period of time the battery switch should be placed OFF to avoid possible overcharging. When external power units providing both AC and DC power are plugged in, the AC power is delivered to the phase sequence relay and the external power contactor. In this configuration, only the external power switch need be ON to permit the DC control circuit to close the external power contactor relay if AC phase rotation is correct. The external power switch in the ON position also permits external DC power to illuminate the external power advisory light and close the DC monitor bus relay, providing power to the DC primary and monitor bus.

DC External Power Receptacle

The DC external power receptacle is located on the right side of the fuselage below the pilot's window and is used to connect 28-volt DC power to the helicopter. With the external power switch ON, 28-volt DC power from an external power source is delivered through the DC power receptacle to illuminate the external power advisory light, close the external power relay, energize the DC primary bus, and close the DC monitor bus relay, providing power to the DC monitor bus.

LIGHTING EQUIPMENT (See figure 38.)

INTERIOR LIGHTS

Pilot's and Copilot's Flight Instrument Panel Lights

The pilot's and copilot's flight instrument panel lights and VOR-TACAN selector lights are individually controlled by rheostats, marked PILOT FLT INST and COPILOT FLT INST, located on the overhead switch panel. With the PILOT FLT INST or COPILOT FLT INST rheostats in the OFF position, the VOR-TACAN lights will operate with a bright, fixed intensity. The VOR-TACAN switch turns the appropriate VOR or TACAN light on. The intensity of the flight instrument lights may be varied by rotating each rheostat. The copilot's flight instrument lights operate from the No. 1 AC primary bus and are protected by a circuit breaker on the copilot's circuit breaker panel. The circuit breaker is marked CO-PLT FLT INST under the general headings CKPT LTS and NO 1 AC PRI. The pilot's flight instrument lights operate from the No. 2 AC primary bus and are protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is marked PILOT FLT INST under the general headings CKPT LTS and NO 2 AC PRI.

NonFlight Instrument Lights

The non-flight instrument panel lights are controlled by a rheostat, marked NON-FLT INST, located on the overhead switch panel. The intensity of the engine and transmission instrument lights, the hydraulic pressure gage lights, the fuel management backlighting, and fuel quantity lights may be varied by rotating the rheostat. The nonflight instrument lights operate from the No. 1 AC primary bus and are protected by a circuit breaker on the copilot's circuit breaker panel. The circuit breaker is marked NON-FLT INST under the general headings CKPT LTS and NO 1 AC PRI.

Console and Overhead Panel Lights

The white lights on the center console, the overhead switch panel, the pilot's side

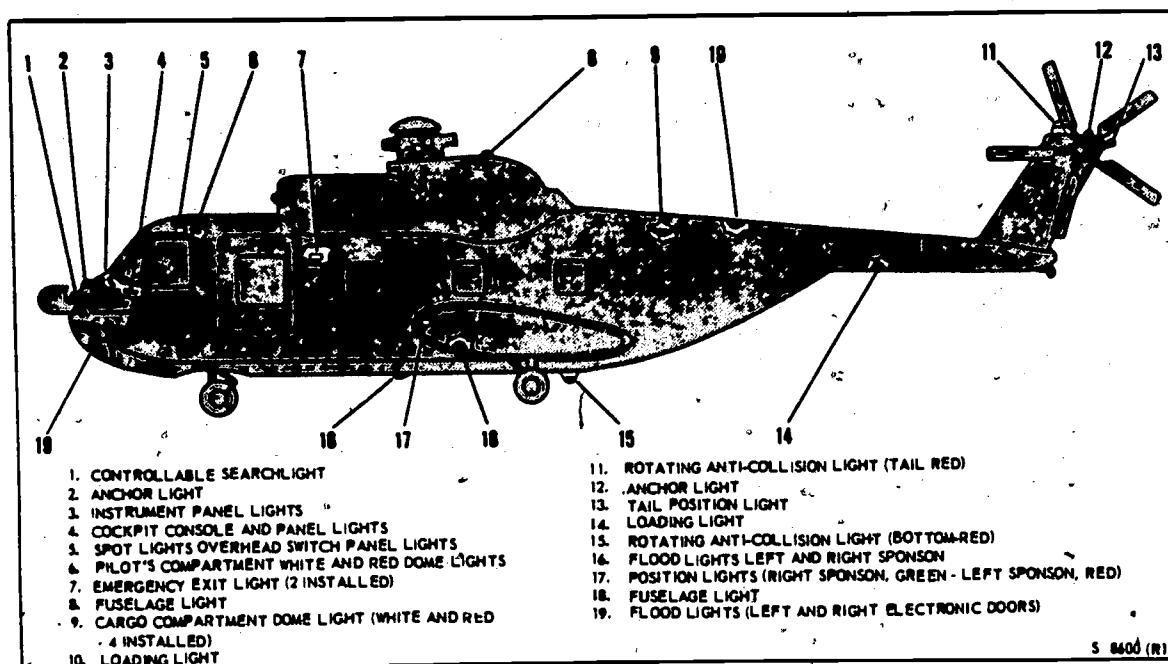


Figure 38. - Lighting system.

console, the copilot's side console, and the MARKER BEACON/RAWS control panel are controlled by rheostats on the overhead switch panel. The rheostats are under the heading CONSOLES LOWER and OVHD. An additional rheostat for red lighting on the lower center console, pilots' side console, and copilot's side console is on the overhead switch panel under the headings LOWER CONSOLE RED LIGHTS. The center console lights operate from the No. 2 AC primary bus and are protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is marked CSL LOWER under the general headings CKPT LTS and NO 2 AC PRI. The cockpit overhead panel lights operate from the No. 1 AC primary bus and are protected by a circuit breaker on the copilot's circuit breaker panel. The circuit breaker is marked CSL OVHD under the general headings CKPT LTS and NO 1 AC PRI.

Cockpit Dome Lights and Secondary Instrument Light

There is one red and one white dome light on the cockpit overhead dome light panel. These lights are controlled by a guarded switch on the dome light panel. The switch is marked DOME LIGHTS - CKPT with the marked positions RED; OFF and WHT.

This switch will supply white light of a fixed intensity. In addition, the red dome light may be used as a secondary instrument light. When the red dome light is used as an instrument light, it should be turned on and its intensity adjusted with the rheostat, marked SECONDARY INST, on the overhead switch panel. These lights are powered by the DC primary bus and are protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked COCKPIT DOME under the general headings INT LTS and DC PRI BUS.

Cockpit Utility Lights

Two portable utility lights with coiled cords are secured, one on each outboard side of the cockpit above the sliding windows. The lights may be adjusted on their mountings to direct the light beams, or they may be removed and used as portable lights. On helicopters modified by TCTO 1H(3)F-582, two additional mounting points are installed; one in front of each pilot's sliding window. The utility lights are each controlled by a rheostat or a pushbutton, located on the end of each light casing. The lens casing of the light may be rotated to position a red filter converting the white light to a red light. The cockpit utility lights operate from the DC primary bus and are protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is

breaker is marked COCKPIT DOME under the general headings INT LTS and DC PRI BUS.

Scroll Checklist Light

The scroll checklist light is controlled by an on-off rheostat switch mounted on the left side of the checklist container. The scroll checklist light operates from the DC primary bus through a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked CHECK LIST under the general headings INT LTS and DC PRI BUS.

Navigator's Panel Light Control

The navigator's panel light control rheostat, marked PNL LTS, is located on the radio rack in front of the navigator's table. The rheostat controls light intensity of the LORAN control panel. The night lighting for the HF head, INTER ICS panel, and RADIO panel is controlled by the LOWER CONSOLE RED LIGHTS rheostat located on the overhead switch panel in the cockpit. The navigator panel lights operate from the No. 2 AC primary bus and are protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is marked NAV under the general headings CREW LTS and NO. 2 AC PRI.

Navigator Utility Light

A portable utility light, with coiled cord and mounting base, is secured to the left side of the cabin beside the navigator's table. The light is controlled by a rheostat on the mounting base. The light may be adjusted on its mounting base to direct the light beam, or it may be removed and used as a portable light. The utility light can be adjusted to operate as a red or white light. The navigator's utility light operates from the No. 2 AC primary bus and is protected by a circuit breaker on the pilot's overhead circuit breaker panel. The circuit breaker is marked MAP LT under the general heading NO. 2 AC PRI.

Hoist Operator's Panel Light Control

The hoist operator's panel light control rheostat, marked PANEL LIGHTS, is loca-

ted forward of the cargo door below the hover trim control. The hoist operator panel lights operate from the No. 2 AC primary bus and are protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is marked HOIST under the general headings CREW LTS and No. 2 AC PRI.

Cabin Dome Lights

The four cabin dome lights (9, figure 38) are controlled by a guarded switch on the cockpit dome light panel. The switch is marked CABIN under the general heading DOME LIGHTS, with marked positions RED, OFF, WHI. The cargo compartment dome lights are equipped with a red and white lamp. The red or white light may be turned on at any time DC power is available at the DC monitor bus. The white light may be turned on only if the guard is lifted. The cabin dome lights operate from the DC monitor bus and are protected by a circuit breaker, located on the pilot's circuit breaker panel. The circuit breaker is marked CABIN DOME LTS under the general headings DC MON.

Standby Compass Light

The standby compass on-off switch is on the compass casing, and the intensity is controlled by the nonflight instrument rheostat powered by the No. 1 AC primary bus.

Loading Lights

Two loading lights (10 and 14, figure 38), one in the ceiling of the cabin above the ramp and one in the bottom of the tail pylon, provide illumination for the ramp loading area. The lights are controlled by a two-position switch, marked LOADING LTS, ON, OFF, located on the overhead switch panel. The loading lights receive power from the DC primary bus and are protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked LOADING under the general headings EXTERIOR LTS and DC PRI BUS.

EXTERIOR LIGHTS
(See figure 38.)

Controllable Searchlight

The forward-facing searchlight located in the nose of the helicopter can move on its hinged mounting bracket forward and down through a 120° arc. In addition, the searchlight can rotate 360° in either direction on its axis. However, it is restricted to 45° left or right until the unit has extended forward and down 110° to 120°, at which time the light will rotate 360°. The extend motor, rotate motor, limit switches and lamp are enclosed in waterproof housings.

There are three searchlight position control switches, one located on each collective pitch grip, marked SLT TRAIN, and the third on the copilot's searchlight and ICS switch panel. The illumination switch, labeled SEARCH, with the marked positions STOW, OFF, and ON, is on the overhead switch panel under the general heading EXTERIOR LTS. The SLT TRAIN switch is a spring-loaded, four-position, thumb switch, center position OFF, with marked positions, FWD, AFT, L, and R. Placing the SEARCH switch in the ON position lights the controllable spotlight and furnishes power to the SLT TRAIN switch to control the searchlight movement. When the SLT TRAIN switch is placed in the FWD position, the controllable searchlight extends by revolving forward and down a maximum of 120° from its stowed position, and it may be stopped at any intermediate position by releasing the switch. Placing the switch in the AFT position retracts the light until the searchlight is in the fully stowed position. By placing the switch in the L or R positions, the searchlight will rotate to the left or right. The searchlight position control switch mounted on the copilot's landing light and ICS switch panel operates in the same manner, and is marked LDG LTS with the marked positions FWD, AFT, L, and R. If the SEARCH switch is placed in the STOW position while the controllable searchlight is extended, the searchlight will automatically go out and then retract to the stowed position. The switch is then placed in the OFF position.

The controllable searchlight operates from the DC primary bus and is protected by circuit breakers on the overhead circuit breaker panel. The circuit breakers are marked SEARCH LIGHT, PWR, and CONT under the general heading EXTERIOR LTS.

Hover Lights

Four hover lights, one located on each side of the electronics compartment door and one located on the lower leading edge of each sponson, are controlled by a push-button switch, marked FLOOD HOVER, on the overhead switch panel. The button portion of the switch is a green lens that illuminates when the switch is pressed, to illuminate the hover lights, and goes out when the button is pressed to turn off the hover lights. The hover lights illuminate an area forward and below the helicopter. The hover lights operate from the DC monitor bus and are protected by three circuit breakers, located on the pilot's circuit breaker panel. The circuit breakers are marked CONT, LH, and RH under the general headings FLOOD LTS, and DC MON.

CAUTION

The hover lights should not be left illuminated for more than 15 minutes at a time, to prevent overheating. The length of time while illuminated and the OAT will determine the cooling off period.

Position Lights

The position lights (17, figure 38), located on the sponsons and pylon, are controlled by two switches on the overhead switch panel. The switches are marked POSITION under the general heading EXTERIOR LTS. The switch will turn the lights on in a STEADY or FLASH configuration or turn the lights OFF. The switch, marked DIM and BRT, will adjust the intensity of the lights accordingly when they are in the STEADY or FLASH configuration. The position lights operate from the DC primary bus and are protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked POS under the general headings EXTERIOR LTS and DC PRI BUS.

Fuselage Lights

Two fuselage lights (8 and 18, figure 38) are installed on the helicopter. One

light is located on the top rear side of the transmission compartment and the other on the bottom of the hull. Both lights are controlled by a three-position switch on the overhead switch panel. The switch is marked FUSELAGE under the general heading EXTERIOR LTS, with marked positions DIM, OFF, and BRIGHT. The lights receive power from the DC primary bus and are protected by a circuit breaker on the overhead circuit breaker panel. The circuit breaker is marked FUS under the general heading EXTERIOR LTS.

Anchor Lights

Two anchor lights (2 and 12, figure 38), one located on the nose and the other on the pylon, are controlled by a two-position switch on the overhead switch panel. The switch is marked ANCHOR under the general heading EXTERIOR LTS, with marked positions ON and OFF. The anchor lights receive power from the battery bus and are protected by a circuit breaker, marked ANCHOR LTS,

on the battery bus circuit breaker panel located on the center console.

Rotating Anti-collision Lights

Two rotating anti-collision lights (11 and 15, figure 38), one located on the top of the tail pylon and the other on the bottom of the fuselage, are controlled by two switches on the overhead switch panel. The switches are under the general headings EXTERIOR LTS and ANTI-COLLISION. The left-hand switch, under the heading FWD with marked positions ON, and OFF, controls the forward anti-collision light. The righthand switch, under the heading AFT with marked positions AFT, ON and OFF, controls the aft rotating anti-collision light. The rotating anti-collision lights operate from the DC primary bus and are protected by two circuit breakers on the overhead circuit breaker panel. The circuit breakers are marked FWD and AFT under the general headings ANTI-COLL and EXTERIOR LTS.

REVIEW

This section has covered the electrical power supply systems and lighting equipment used on the HH-3F. To complete a preflight and certify the aircraft ready for flight, you will need to acquaint yourself thoroughly with these systems.

(Now answer the following review questions.)

23. The primary bus provides power for all components that are essential for which flight operations?

23.-C (Refer to page 41)

- A. SAR only
- B. Night VFR only
- C. Night instrument only
- D. Any flight operations

24. If the No. 1 generator fails, you should expect to lose all components powered by the _____ bus.

24.-B If you lose a generator, you will lose all monitor buses. (Refer to pages 41 and 42)

- A. No. 1 primary AC
- B. No. 1 AC monitor
- C. primary DC
- D. No. 2 primary AC

25. DC power is supplied by two _____ ampere converters.

25.-A (Refer to page 43)

- A. 28V., 200
- B. 26V., 200
- C. 28V., 260
- D. 26V., 250

26. Assume that the No. 2 converter fails. Which buses will be dropped from the line?

26.-C (Refer to page 44)

- A. No. 1 AC primary
- B. DC primary
- C. DC monitor
- D. No. 2 DC primary

27. The AC external power receptacle is located on the _____.

27.-D (Refer to page 45)

- A. right side of the fuselage aft of the sponson
- B. right side of the fuselage forward of the cabin door
- C. left side of fuselage forward of the sponson
- D. left side of fuselage aft of the sponson

28. Which switches must be on when only AC external power is plugged into the aircraft?

28.-B (Refer to page 47)

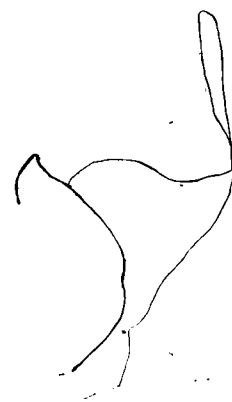
1. External power
2. Battery
3. Converters
4. Generators

- A. 1 and 3 only
- B. 1 and 2 only
- C. 1, 3, and 4
- D. 2, 3, and 4

29. The pilot's flight instrument lights operate from the _____ bus.

29.-C (Refer to page 47)

- A. No. 1 AC primary
- B. DC primary
- C. No. 2 AC primary
- D. DC essential



HYDRAULIC AND LANDING GEAR SYSTEMS

OBJECTIVES

When you complete this section, you will be able to:

1. Summarize the operation of the utility hydraulic system.
2. Identify the utility hydraulic system equipment components and explain their function.
3. Interpret the utility hydraulic system schematic diagram.
4. Describe the landing gear system.
5. Identify the landing gear system components and explain their function.
6. Explain the landing gear emergency extension system.
7. Interpret the landing gear system schematic diagram.

HYDRAULIC SYSTEMS

Three hydraulic systems, the primary, auxiliary, and utility, are incorporated in the helicopter. The primary and auxiliary hydraulic systems assist in flight control. The utility hydraulic system provides hydraulic power for the main landing gear, nose landing gear, ramp, and APU start system and rescue hoist system.

the auxiliary hydraulic system is capable of independent operation, if desired.

Since the primary and auxiliary hydraulic systems are described in the Flight Control Systems section of this pamphlet, these systems will not be covered in this section.

UTILITY HYDRAULIC SYSTEM

The utility hydraulic system (figure 42) consists of a fluid tank, hydraulic pump, panel package and a pressure indicating system. The system supplies 3,000 psi pressure to the nose landing gear, main landing gear, APU start system, ramp, and rescue hoist system. In addition, a heat exchanger is incorporated into the utility system to cool hydraulic fluid, if necessary, returning to the reservoir. On the ground, hydraulic power may be obtained from a hydraulic test stand connected to the external hydraulic pressure couplings, or by operating the APU or the rotor system. In flight, the utility pump, driven by the main gear box, supplies 3,000 psi pressure to the utility panel package for direct distribution and for reduced pressure distribution to other systems. Utility hydraulic pressure is displayed on the UTI HYD PRESS indicator on the instrument panel.

PRIMARY HYDRAULIC SYSTEM

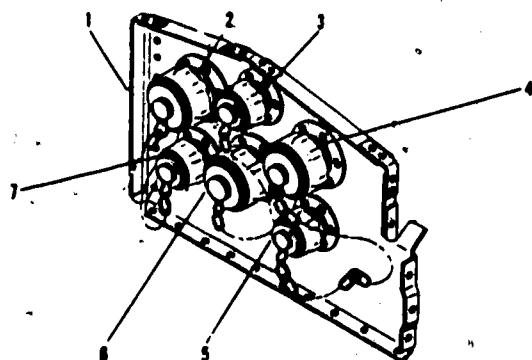
The primary hydraulic system provides power for the primary servocylinders, which assist in flight control. Normally operated in series with the auxiliary hydraulic system, the primary hydraulic system is capable of independent operation, if desired.

AUXILIARY HYDRAULIC SYSTEM

The auxiliary hydraulic system provides power for the auxiliary servocylinder, which assists in flight control. Normally operated in series with the primary hydraulic system,

EXTERNAL HYDRAULIC PRESSURE CONNECTIONS

External hydraulic pressure couplings (figure 39) are provided for testing the hydraulic systems. A UTILITY PRESSURE coupling and a UTILITY SUPPLY coupling are installed on the coupling support aft and to the right of the main gear box. The UTILITY SUPPLY coupling provides for the return of the hydraulic fluid from the system to the external source of hydraulic power. When not in use, the couplings are covered with dust caps to prevent entry of foreign



- | | |
|-----------------------------------|-------------------------------------|
| 1 Coupling Support | 5 Primary Servo Pressure Coupling |
| 2 Auxiliary Servo Supply Coupling | 6 Utility Supply Coupling |
| 3 Utility Pressure Coupling | 7 Auxiliary Servo Pressure Coupling |
| 4 Primary Servo Supply Coupling | |

Figure 39. - External hydraulic pressure connections.

matter. Access to the couplings is gained by hinging down the right transmission service platform.

EQUIPMENT COMPONENTS

FLUID TANK (RESERVOIR)

Hydraulic fluid for the utility hydraulic system is supplied from the utility fluid tank (figure 42, item 8), aft and to the right of the main gear box. Ports for supply and return, a vent line, a drain plug, sight level gage, a filler neck, a scupper drain, and a servicing instructions decal are on the tank. When filled to the FULL mark on the sight level gage, the fluid tank contains 3.05 gallons of fluid. If the filter element becomes clogged, an in-

ternal relief valve operating at 6 to 8 psi pressure will bypass the filter element. Access to the fluid tank is gained from the transmission service platform and by opening the ACCESS PANEL and the UTILITY HYDR REFILL ACCESS PANEL on the right side of the aft main rotor fairing.

UTILITY PUMP

A constant pressure, variable flow piston-type pump (figure 42, item 11) delivers hydraulic fluid at 3,000 psi pressure to the utility hydraulic system. Hydraulic fluid is drawn by the pump from the system fluid tank and delivered under pressure to the utility panel package. The utility pump is mounted on the No. 2 oil pump between the primary and auxiliary pumps on the lower right half of the main gear box rear cover. Access to the pump is gained by hinging down the right transmission service platform.

CHECK VALVES

The external pressure line to the Utility panel package contains a one-way check valve (figure 42, item 10), which protects the external coupling from back pressure. Access to the check valve is gained by hinging down the ACCESS PANEL on the right side of the aft main rotor fairing.

UTILITY PANEL PACKAGE

Hydraulic fluid in the utility hydraulic system is directed through the utility panel package (figure 40) on the support panel below the system fluid tank. The utility panel package, operating at 3,000 psi pressure, is a self-contained unit incorporating a 10-micron filter. If the filter becomes clogged, a differential pressure indicator pin will indicate at 100 ± 20 psi differential pressure. A snubber to equalize system pressures, a relief valve, preset to open at 3,500 psi pressures, and a four-way solenoid valve, also are incorporated in the utility panel package. Access to the utility panel package is gained by hinging down the right transmission service platform and the ACCESS PANEL on the right side of the aft main rotor fairing.

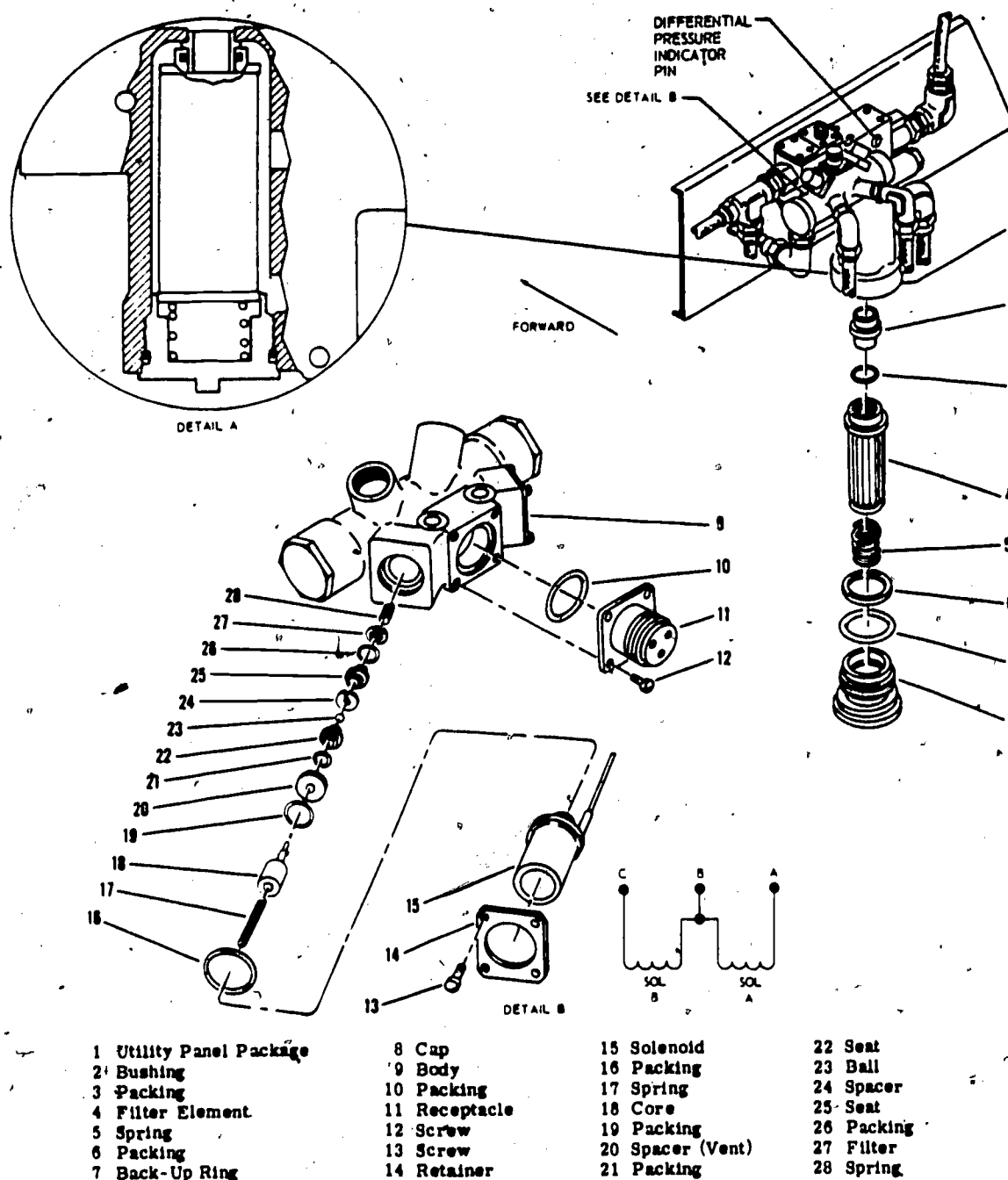
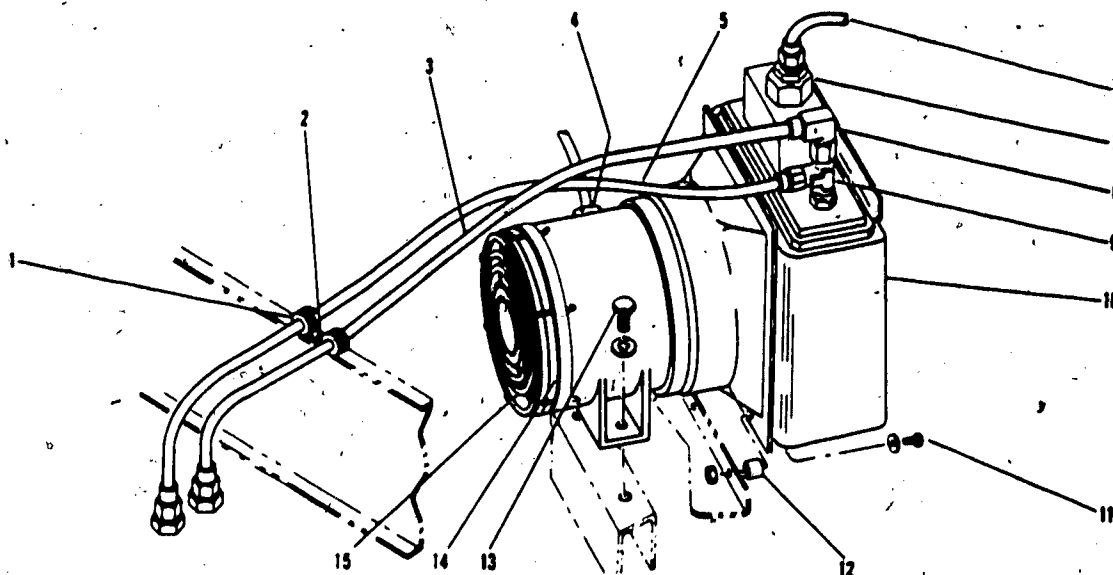


Figure 40. Utility panel package.

UTILITY PANEL PACKAGE FILTER

The utility panel package filter (figure 40) consists of a filter cap, 10-micron stainless steel filter element, bushing, spring, back-up ring, and packing. Should the filter become clogged, a differ-

ential pressure indicator pin will extend when 100 ± 20 psi differential pressure exists across the filter and the hydraulic fluid temperature is between 0.0°C . (32°F) and 16.7°C . (62°F .) Inspect frequently to ensure the pin has not extended. If the pin has extended, clean the filter in accordance with T.O. 9H3-1-1. The differential



- | | | |
|---------------------------------------|----------------------------|----------------------|
| 1 Clamp | 6 Hose (Return) | 11 Bolt, Washer, Nut |
| 2 Screw, Washer, Nut | 7 Bushing, Union, Packings | 12 Spacer |
| 3 Hose (Rescue Hoist Return) | 8 Bushing, Packing | 13 Bolt, Washer |
| 4 Disconnect Plug | 9 Tee, Nut, Packing, Ring | 14 Clamp |
| 5 Hose (Ramp and Landing Gear Return) | 10 Heat Exchanger | 15 Fan Guard |

Figure 41. - Heat exchanger.

pressure indicator pin must then be reset by manually pressing the pin into the utility panel package housing. Access is gained by hinging down the right transmission service platform and by hinging down the ACCESS PANEL on the right side of the aft main rotor fairing.

HEAT EXCHANGER

The heat exchanger (figure 41), on the right side of the transmission deck, consists of a cooler, blower, and associated ducts. All utility hydraulic system return lines are routed through the cooler. The blower blows outside air across the cooler to dissipate heat and prevent fluid temperature from exceeding 93.3° C. (200° F.) The blower operates whenever the OIL COOLER BLOWER circuit breaker on the copilot's circuit breaker panel, and the OIL COOL BLO CONT circuit breaker on the overhead circuit breaker panel, are engaged. A thermostatic bypass valve opens to bypass fluid around the core to the return line when fluid temperature is below 26.7° C. (80° F.) or pressure drop across the core rises

between 35 to 45 psi. A blower motor over-temperature sensor is contained within the motor and can shut the motor off by de-energizing the blower control relay. A screen-type fan guard is secured over the blower inlet portion of the heat exchanger by a band-type clamp.

UTILITY HYDRAULIC PRESSURE INDICATING SYSTEM

The utility hydraulic pressure indicating system consists of a pressure transmitter, pressure indicator, and snubber. The system indicates the pressure being supplied to the utility panel package. The snubber within the utility panel package dampens pressure oscillations to the pressure transmitter.

PRESSURE TRANSMITTER

The pressure transmitter (figure 42 item 9), on the right side of the transmission deck, transmits electrical impulses

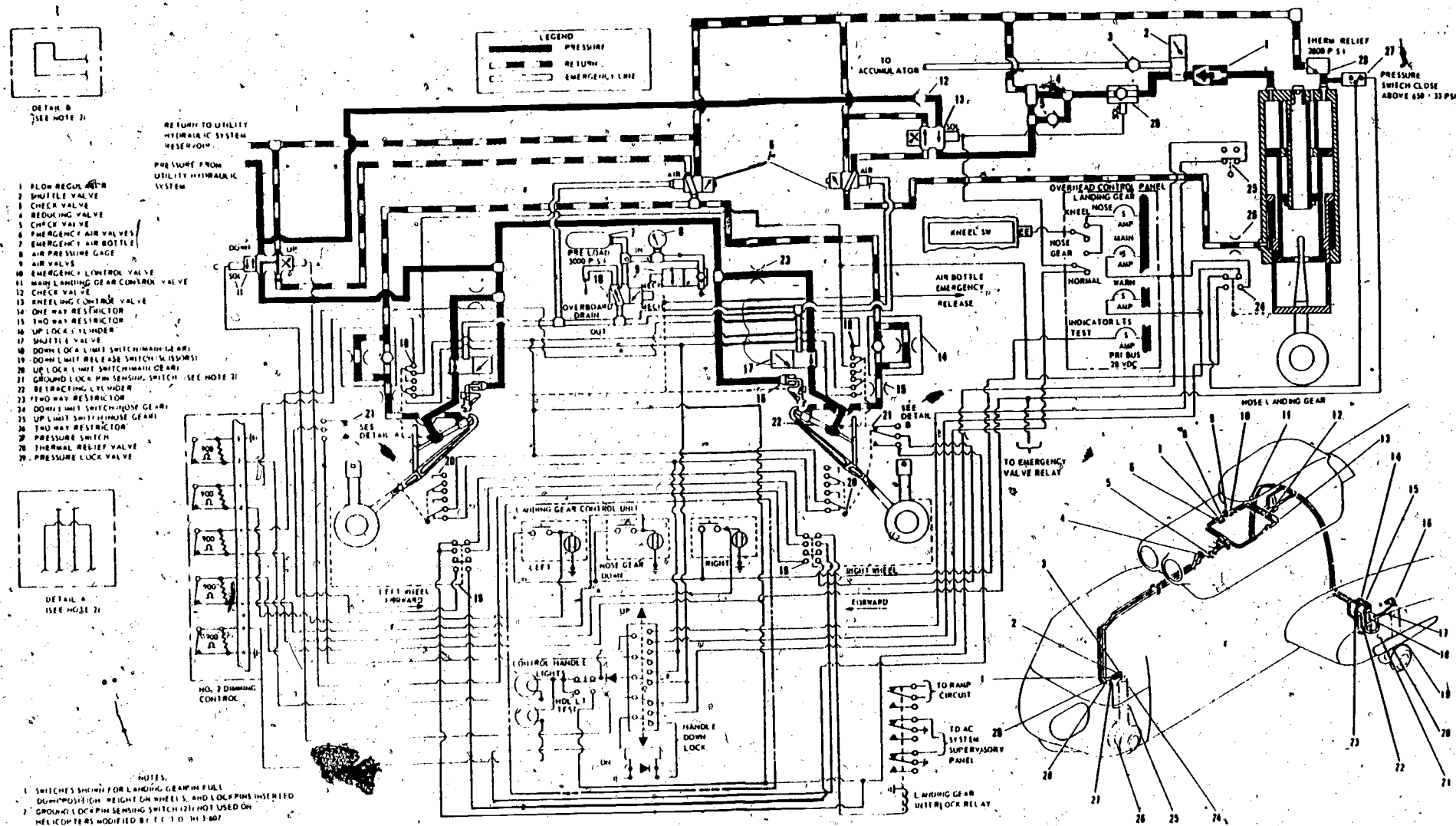


Figure 43. - Landing gear system - schematic diagram.

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to the HYD PRESS UTI indicator on the instrument panel. The pressure transmitter has an operational range of zero to 5,000 psi pressure. Access to the transmitter is gained by winging down the right transmission service platform.

UTILITY PRESSURE INDICATOR

The utility pressure indicator, near the lower center of the instrument panel, indicates utility hydraulic system pressure. The indicator dial has a range of 0 to 4,000 psi.

LANDING GEAR

The landing gear system comprises the retractable main landing gear mounted in the sponsons and the retractable (kneeling) nose landing gear mounted immediately aft and below the cockpit. The nose landing gear is a swivel type and can be locked in the trailing position for parking. The main and nose landing gears are normally operated hydraulically, but in the event of hydraulic failure, an emergency system of compressed air will lower the main landing gear, and a switch will actuate a valve to direct APU accumulator hydraulic pressure to lower the nose gear. While the helicopter is on the ground, the nose landing gear may be kneeled to increase ground clearance at the aft ramp for cargo loading.

LANDING GEAR SYSTEM (RETRACTABLE)

The landing gear system consists of a landing gear control unit with indicating lights, retractable main landing gear, and retractable (kneeling) nose landing gear. (Turn to figure 43 at this time.) Hydraulic power extends and retracts both main and nose landing gear, and electrical components sequence the operations. When the nose and main landing gear are fully extended, the control unit indicating lights illuminate. The control handle lights illuminate at the start of the nose and main landing gear cycle and go off at the end of the cycle. If the system fails, the main and nose landing gear may be extended through the emergency extension system.

A down-limit release switch (figure 43, item 19), attached to each main landing gear, is actuated by compression of the shock strut. The down-limit release switches, connected in series, prevent inadvertent retraction of the landing gear while the helicopter is on the ground. In addition, the ground lockpin sensing switches (21) prevent inadvertent retraction of the landing gear while the ground lockpins are installed. The ground lockpin sensing switches are normally closed and are actuated when ground lockpins are installed. When the ground lockpins are removed, the switch contacts close. As helicopter weight is removed from the gear, the shock strut extends, closing the downlimit release switch contacts. This energizes a coil in the landing gear control unit and unlocks the control handle.

After the down-limit release switches have closed, electrical power is available at the landing gear control unit (11) to retract the nose and main landing gear. Placing the control handle in the UP position illuminates the control handle lights through the uplock limit switches on the upper drag links or the up-limit switch (25) in the nose gear, energizes the up-coil in the main landing gear control valve, and energizes the kneeling valve (13) and pressure lock valve (29). Hydraulic pressure flows through the kneeling control valve, an emergency release valve (6), and a two-way restrictor (26), to the kneeling cylinder in the nose gear, permitting the cylinder to raise the nose gear. The return flow passes through a flow regulator (1), shuttle valve (2), pressure lock valve, and a check valve (5) to the return port of the kneeling control valve (13). Also, hydraulic pressure flows through the main landing gear control valve (11), an emergency release valve (6), plus a two-way (15) and a one-way (14) restrictor, to the retracting cylinder (22) of the main landing gear. An integral down-lock mechanism in the retracting cylinder is released upon application of pressure, permitting the piston to extend and raise the main landing gear. The return flow passes through a shuttle valve (17) in the retracting cylinder and a two-way restrictor (23), to the return port of the main landing gear control valve. As the main and nose landing gears start to retract, the main gear down-lock limit switches (18) and nose gear down-limit switch are tripped (24). This interrupts electrical power to the control unit

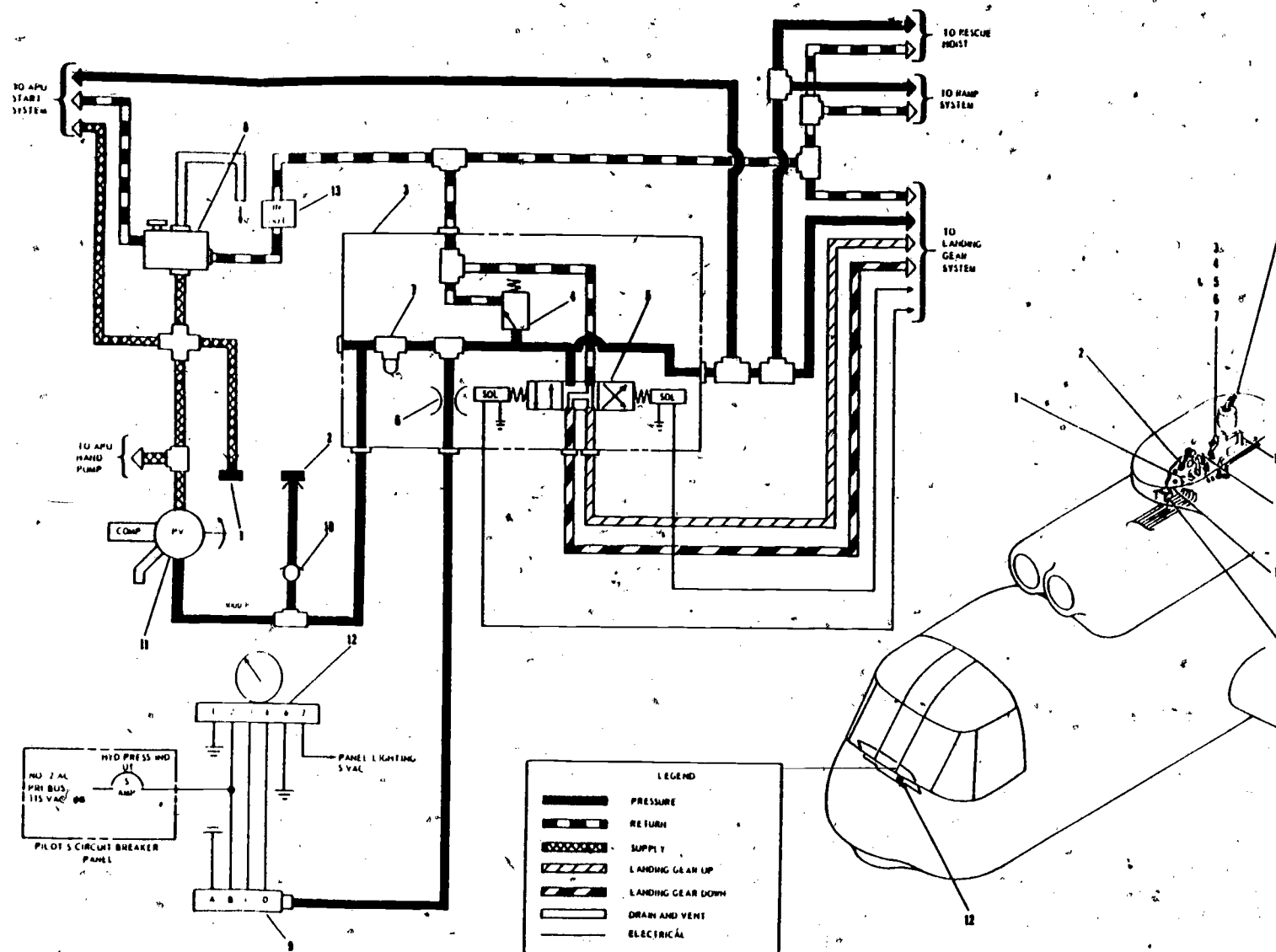


Figure 42. - Utility hydraulic system - schematic diagram.

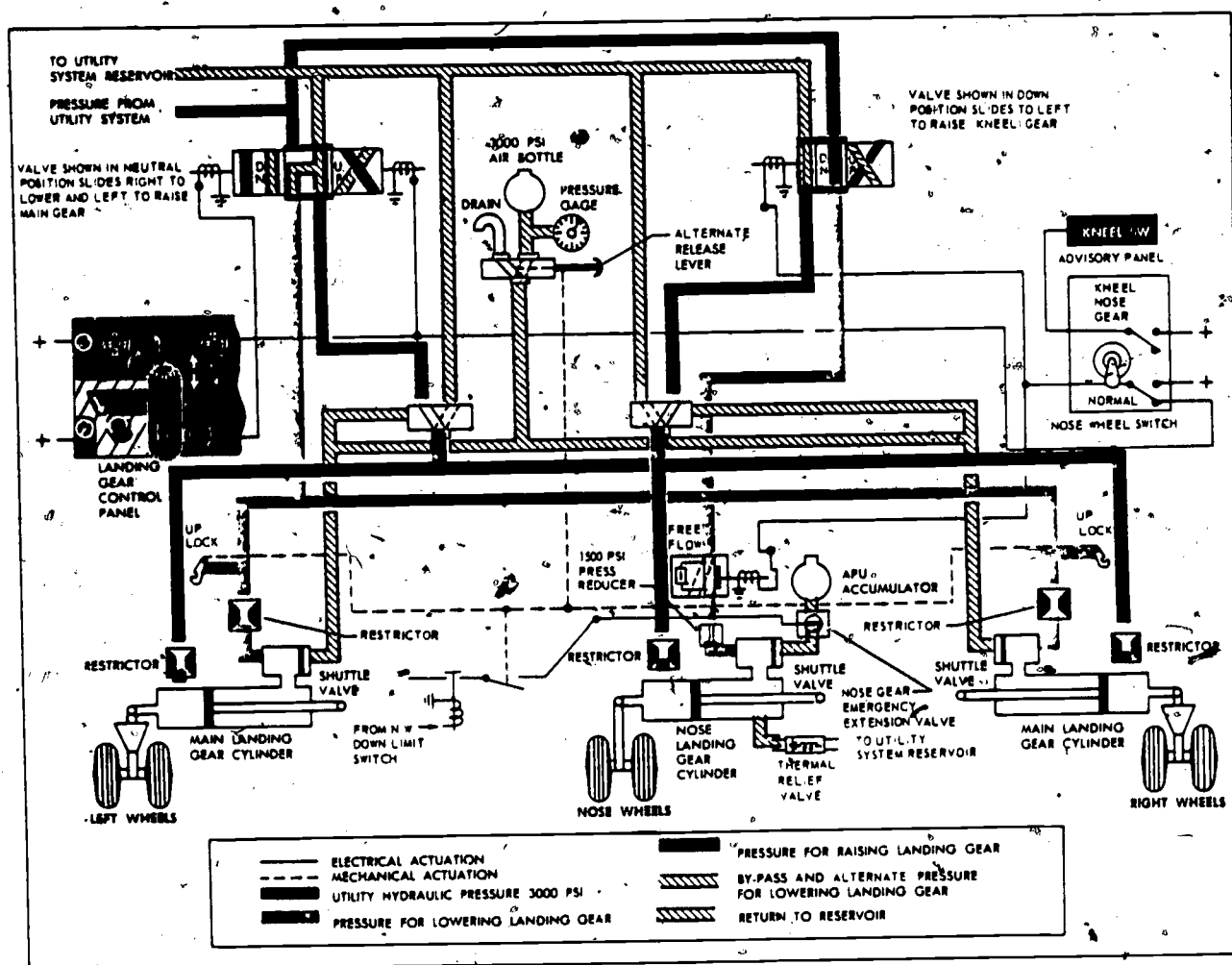


Figure 43A. - Landing gear system - schematic diagram (simplified).

LEFT, RIGHT, and NOSE GEAR DOWN indicator lights and completes another circuit to the control unit, making electrical power available to lower the landing gear.

When the nose and main gears are fully retracted, the main gear uplock limit switches are actuated, interrupting the electrical circuit to the landing gear control valve and control handle lights. The up-limit switch in the nose gear interrupts an electrical circuit to the control handle lights. Placing the control handle in the DN position illuminates the control handle

lights through the downlock limit switches and down-limit switch (24) in the nose gear, and energizes the down coil in the main landing gear control valve (11). This also de-energizes the kneeling valve (13) and pressure lock valve (29). Hydraulic pressure flows through the kneeling valve (13), pressure reducer (4), pressure lock valve (29), shuttle valve (2), and flow regulator (1), to the kneeling cylinder in the nose gear, permitting the cylinder to extend the nose gear. The return flow passes through a two-way restrictor (26), the emergency return valve (6), and to the return port of the

nose kneeling valve (13). Also, hydraulic pressure flows through the main landing gear control valve to the uplock cylinder (16), extending the piston and unlocking the main gear. Simultaneously, pressure flows through a two-way restrictor (23) and shuttle valve (17) to the retracting cylinder (22), retracting the piston and lowering the main gear. Return flow passes through a two-way restrictor (15), one-way restrictor (14), and the emergency release valve (6) to the return port of the main landing gear control valve (11).

As the main and nose landing gears start to extend, the uplock limit switches are actuated, completing an electrical circuit to the up contacts in the landing gear control unit, making electrical power available to raise the landing gear. When the retracting cylinder has fully retracted, an integral locking mechanism engages, locking the main landing gear in the down position. When the main and nose gears are fully extended, the main gear downlock limit switches and the down-limit switch in the nose gear are tripped, and pressure build-up in the nose gear kneeling cylinder closes the contacts of the pressure switch. This completes an electrical circuit to the LEFT, RIGHT, and NOSE GEAR DOWN indicators and interrupts the electrical circuit to the down contacts of the control unit, de-energizing the down coil of the main landing gear control valve and the circuit to the control handle lights.

Emergency provisions are provided in the event of electrical or hydraulic failure when the nose and main landing gears are in the up and locked position. These include the emergency control valve (figure 50, item 6) emergency air valves (2), emergency air bottle (3), air pressure gage (4), and air valve (5), which permit lowering the main landing gear by compressed air. Simultaneously, the nose gear is lowered by hydraulic pressure through additional emergency provisions, which include an emergency air valve (2), a solenoid operated emergency release valve (10), accumulator (9), air pressure gage (7), and air valve (8). When the NOSE GEAR kneeling switch on the overhead control panel is positioned to KNEEL, the kneeling valve and the pressure lock valve are actuated. This allows the kneeling cylinder to vent through the open pressure lock valve and the kneeling valve to the hydraulic return line. Also, this

allows hydraulic pressure through the actuated kneeling valve to kneel the nose gear. When the NOSE GEAR kneel switch is positioned to NORMAL, the nose gear extends to the static position. Hydraulic power for the landing gear system is supplied by the utility hydraulic system at 3,000 psi pressure.

Control Unit

The landing gear control unit, on the lower center of the instrument panel, provides control for raising and lowering the main and nose landing gear. The control unit consists of an UP and DN control handle with two lights in its wheel-shaped knob, DN LCK REL arm, a HDL LT TEST button and LEFT, RIGHT, and NOSE GEAR DOWN indicating lights. The indicating lights illuminate when the applicable landing gear is down and locked. Pushing in each indicating light determines if the light is operable. The control handle lights illuminate whenever the nose or main gear is in motion and not locked in the up or down position. When the helicopter is on the ground, the control handle is locked in the down position by a solenoid actuated bolt to prevent accidental retraction of the gear. The handle is unlocked when weight of the helicopter is sufficiently off the wheels to actuate the down-lock release limit switches. Pressing the HDL LT TEST button determines whether its lamps are operative.

Control Valve

The four-way solenoid operated main landing gear control valve (figure 43, item 11) is an integral part of the utility panel package. The valve directs hydraulic pressure to either side of the actuating cylinder to retract or extend the main landing gear. Limit switches at each end of the retracting or extending cycle break the circuit, releasing the solenoids and placing the control valve in bypass condition, blocking off pressure. The bypass characteristic prevents a hydraulic lock, allowing the landing gear to drop freely when released by emergency procedure.

Two-Way Restrictor

The two-way restrictor (figure 43, item 15), in the landing gear downline attached to the actuating cylinder, dampens pressure

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surges and limits the flow of hydraulic fluid. The two-way restrictor may be removed by disconnecting the tubing from each end.

Kneeling Control Valve

The four-way two-position solenoid operated kneeling control valve (figure 43, item 13) directs hydraulic pressure to either side of the actuating cylinder to extend or retract the nose gear. The valve is controlled by a two-position toggle switch on the overhead control panel and/or the control unit handle.

Two-Way Restrictor-Filter

The two-way restrictor-filter, in the landing gear upline attached to the retracting cylinder, limits flow of hydraulic fluid which controls rate of extension and retraction of the retracting cylinders. The restrictor-filter also aids in synchronizing up and down motion of the landing gears. The two-way restrictor-filter may be removed by disconnecting the tubing from each end.

Main Landing Gear Retracting Cylinder

The hydraulically operated retracting cylinder (figure 44, item 1) is between the upper end of the upper drag link and upper and lower links. The retracting cylinder extends to retract the landing gear and compresses to extend the landing gear. The retracting cylinder has an internal positive lock to secure the piston in a compressed position, and a microswitch to indicate when the landing gear is in the fully down and locked position. In the down and lock position, the retracting cylinder is fully compressed and locked, bringing the upper and lower links and the upper and lower drag links into position against physical stops. This holds the gear in a positive down and locked position.

Uplock Cylinder

The uplock cylinder (figure 45, item 4) is a hydromechanical unit between the

uplock mechanism and a bracket in the sponson. The cylinder operates the uplock mechanism to lock the landing gear in retracted position and hydraulically releases the uplock mechanism so that the landing gear can be lowered. The uplock mechanism can be actuated mechanically through the emergency extension system.

Uplock Limit Switch

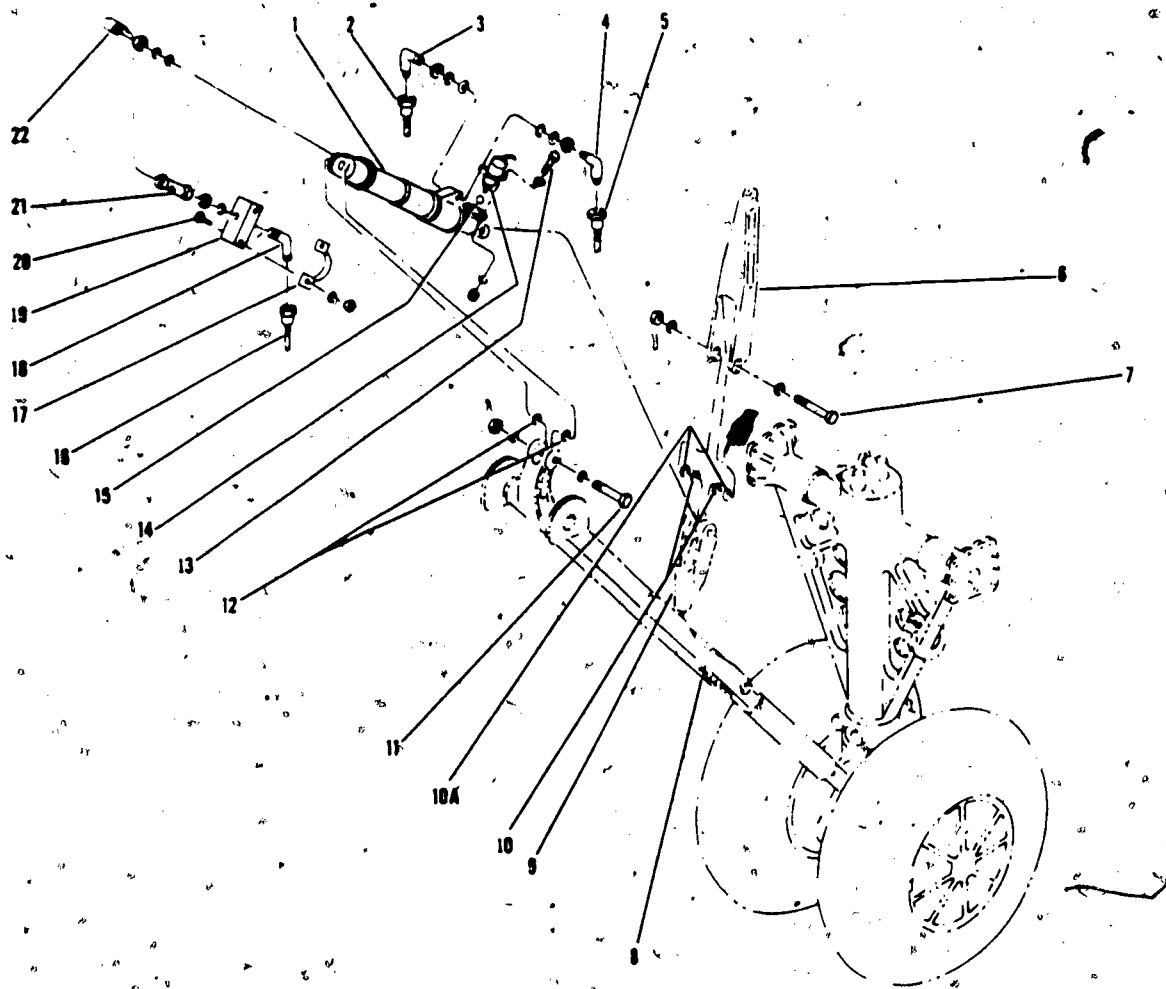
The landing gear uplock limit switch is on a bracket at the bottom of the upper drag link. The switch should be actuated simultaneously with the uplock hook, engaging the landing gear lug. This will interrupt the circuit to the gear-up solenoid in the main landing gear control valve and cause the lights in the control handle to go off. Adjustment is made by threading adjusting nuts on each side of the bracket when the landing gear is fully retracted and locked.

Ground Lockpin Sensing Switch

The landing gear ground lockpin sensing switch is on a bracket at the bottom of the upper drag link. The switch should be actuated when the ground lockpin is installed. This will interrupt the circuit from the gear-up solenoid in the main landing gear control valve and prevent inadvertent landing gear retraction.

Down-Limit Release Switch

The down-limit release switches are on the lower aft end of each trunnion and are actuated by compression and extension of shock struts. When the weight of the helicopter is on the wheels, the shock struts are compressed and the contacts of the switches are open, thereby allowing the solenoid-operated locking pin to lock the handle of the landing gear control unit. The switches also complete the underfrequency control circuit through the supervisory panel to monitor the generator for underfrequency when the helicopter is on the ground. Also, the switches complete a ramp control circuit to the forward ramp system so that the forward ramp may be lowered when the helicopter is on the ground.



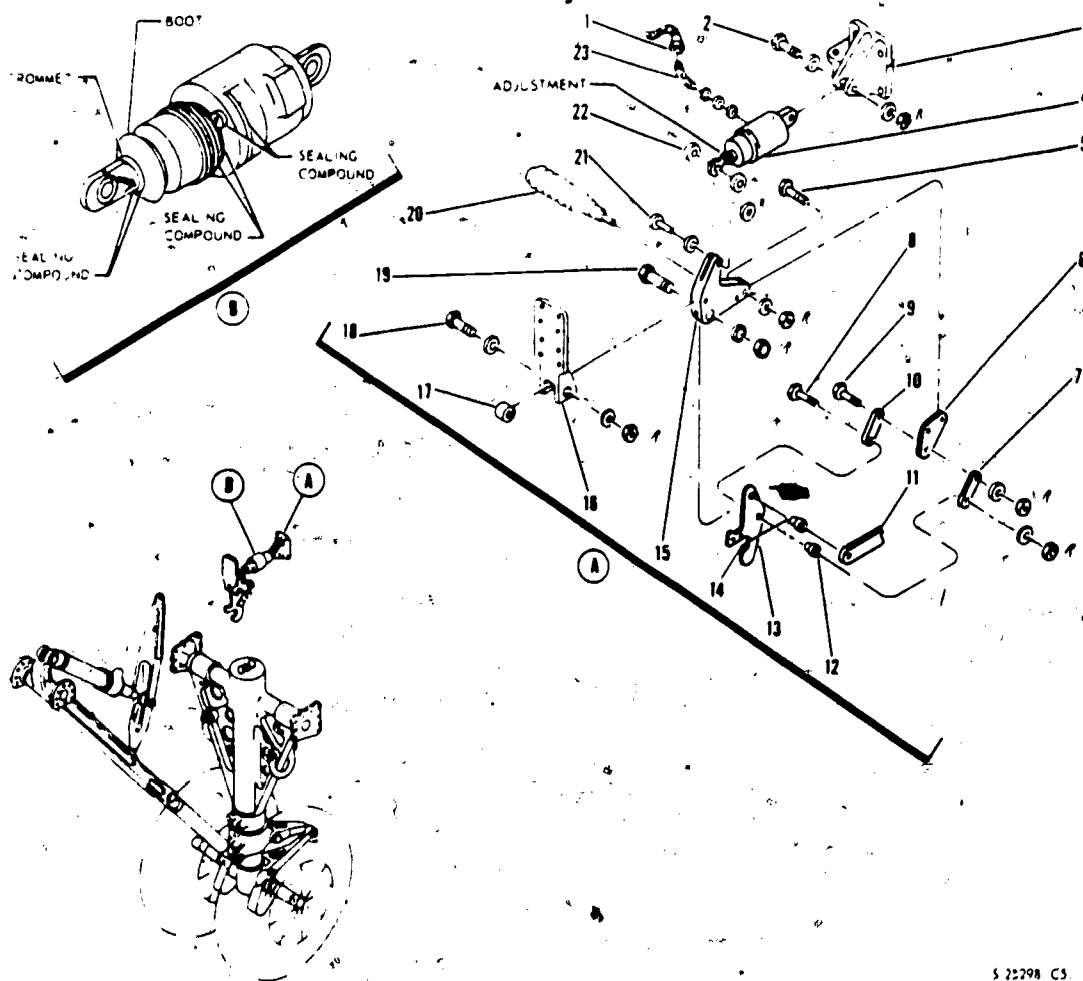
- | | | | |
|------------------------------|----------------------------------|-----------------------------------|-------------------------------|
| 1 Retracting Cylinder | 6 Upper Link | 11 Bolt, Washers, Nut, Cotter Pin | 17 Clamp |
| 2 Downline Hose | 7 Bolt, Washers, Nut, Cotter Pin | 12 Washers | 18 Elbow, Washer, Nut |
| 3 Elbow, Washer, Nut, Gasket | 8 Upper Drag Link | 13 Bolt, Washers, Nut | 19 Bracket |
| 4 Elbow, Washer, Nut, Gasket | 9 Lower Link | 14 Downlock Limit Switch | 20 Bolts, Washers, Nuts |
| 5 Emergency Air Hose | 10 Washers | 15 Ball | 21 Upline Tube |
| | 10A Washers | 16 Upline Hose | 22 Elbow, Washer, Nut, Gasket |

Figure 44. - Main landing gear retracting cylinder.

When the weight of the helicopter is removed from the wheels, the struts extend and the switches close, activating the solenoid and releasing the control handle. This also opens the underfrequency control circuit and the ramp control circuit. Both down-limit release switches must be actuated to unlock the control handle.

Main Landing Gear Extension And Retraction Links

The main landing gear extension and retraction links (figure 46) consist of the upper and lower drag links, and the upper and lower links. The links provide



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- 1 Hydraulic Hose
- 2 Bolt, Washers, Nut, Cotter Pin
- 3 Fitting
- 4 Uplock Cylinder
- 5 Bolt, Washer, Nut, Cotter Pin
- 6 Link
- 7 Link
- 8 Bolt, Washer, Nut, Cotter Pin

- 9 Bolt, Washer, Nut, Cotter Pin
- 10 Link
- 11 Spring
- 12 Bearing
- 13 Arm
- 14 Bearing
- 15 Support
- 16 Support
- 17 Spacer

- 18 Bolt, Washers, Nut, Cotter Pin
- 19 Bolt, Washer, Nut, Cotter Pin
- 20 Emergency Release Engagement Pin
- 21 Pin, Washers, Cotter Pin
- 22 Washers
- 23 Elbow, Nut, Gasket, Packing

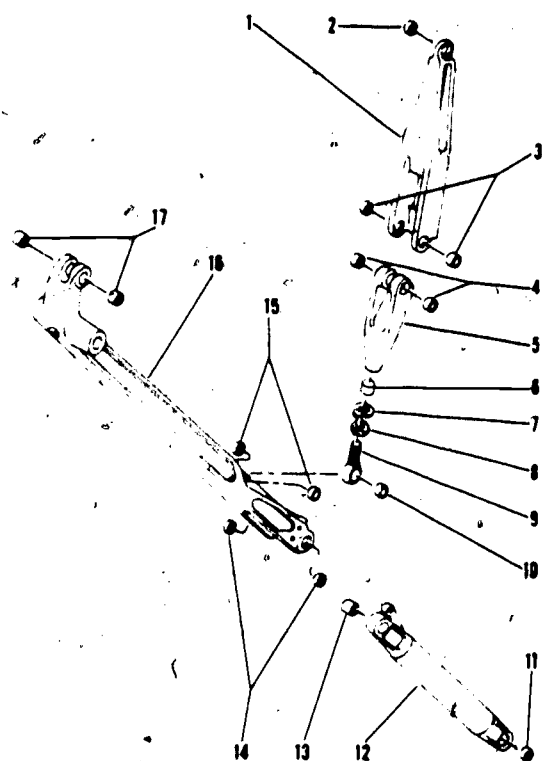
Figure 45. - Main landing gear uplock cylinder.

the mechanical linkage to extend and retract the main landing gear. The upper and lower drag links are between the lower end of the trunnion and the support on the sponson. The upper and lower links are between the upper drag link and the support on the sponson. The upper and lower links join to a pivot (knee joint) which has an over-center action to maintain the landing gear in the extended position. A safety hole through both the upper and lower links at

the pivot provides for installation of the landing gear safety pin to prevent inadvertent retraction of the landing gear during ground handling.

Main Shock Strut

The shock strut is an integral part of the main landing gear and consists of



- | | |
|--------------|--------------------|
| 1 Upper Link | 10 Rod End Bearing |
| 2 Bearing | 11 Bushing |
| 3 Bushings | 12 Lower Drag Link |
| 4 Bushings | 13 Bushing |
| 5 Lower Link | 14 Bushings |
| 6 Insert | 15 Bushings |
| 7 Lock | 16 Upper Drag Link |
| 8 Nut | 17 Bushings |
| 9 Rod End | |

Figure 46. - Main landing gear extension and retraction links.

the trunnion and piston. The dual wheels and brake are attached to the axle at the lower end of the piston. A pair of torque arms, secured to the trunnion and piston, prevent the piston from swiveling, but allow vertical movement. The trunnion is the cylinder of the shock strut and secures the main landing gear to the sponson. The lower drag link is also secured to the trunnion. The shock strut is hydro-pneumatic with an internal floating piston which separates the air and the hydraulic fluid. The air chamber is in the lower piston and is serviced through the air valve, aft between the dual wheels. The hydraulic fluid is added through a filler plug at the top of the trunnion and bled of air through a bleeder plug, also at the top of the trunnion. The trunnion has bosses for attaching the tow ring and limit switches. The

shock strut absorbs shock during landing and ground operations.

Main Shock Strut Filler Plug

A filler plug is at the top of the trunnion for servicing the shock strut with hydraulic fluid. When the shock strut is being serviced, a hydraulic line is threaded on the stem, preventing spilling of excess fluid and allowing greater filling control. The bleeder plug, next to the filler plug, provides a means for allowing the trapped air to escape and a way to ascertain that the strut is filled.

WARNING

To prevent injury to personnel and possible loss of life, do not remove hydraulic filler plug unless air pressure has first been released.

Emergency Extension System

The landing gear emergency extension system (figure 50) consists of an uplock emergency release mechanism, emergency control valve, air bottle, emergency air valves, pressure gage, emergency release valve, emergency valve relay, and a switch. The main landing gear emergency extension system provides for landing gear extension in event of electrical or hydraulic failure of the main landing gear system. Actuation of the emergency extension release handle disengages an emergency release pin in the uplock mechanism and simultaneously opens the emergency control valve to permit an air bottle, preloaded to 3,000 psi air pressure, to discharge through the emergency control valve. This air charge actuates the emergency air valves to vent the return side of the retracting cylinder and the return side of the kneeling cylinder to the utility hydraulic fluid tank. The air charge also displaces a shuttle valve and operates the retracting cylinder to lower the main landing gear. Also, actuation of the emergency extension release handle closes a switch at the bottom of the handle, completing an electrical circuit from the LAND GEAR EMER DN circuit breaker through the emergency valve relay to the emergency release valve,

opening the valve. The contacts of the emergency valve relay are open when the nose gear is extended to prevent accidental discharge of the accumulator to the nose gear when the helicopter is on the ground. The open emergency release valve permits the auxiliary power unit accumulator to discharge hydraulic fluid under pressure through the valve. The hydraulic charge displaces a shuttle valve and causes the nose gear to extend. A red safety string having a tensile strength of 2 to 5 pounds

is installed between the emergency release handle and handle bracket to provide a visual check for accidental actuation of the emergency release handle.

Unlock Emergency Release Mechanism

The unlock emergency release mechanism (figure 47) for each landing gear consists

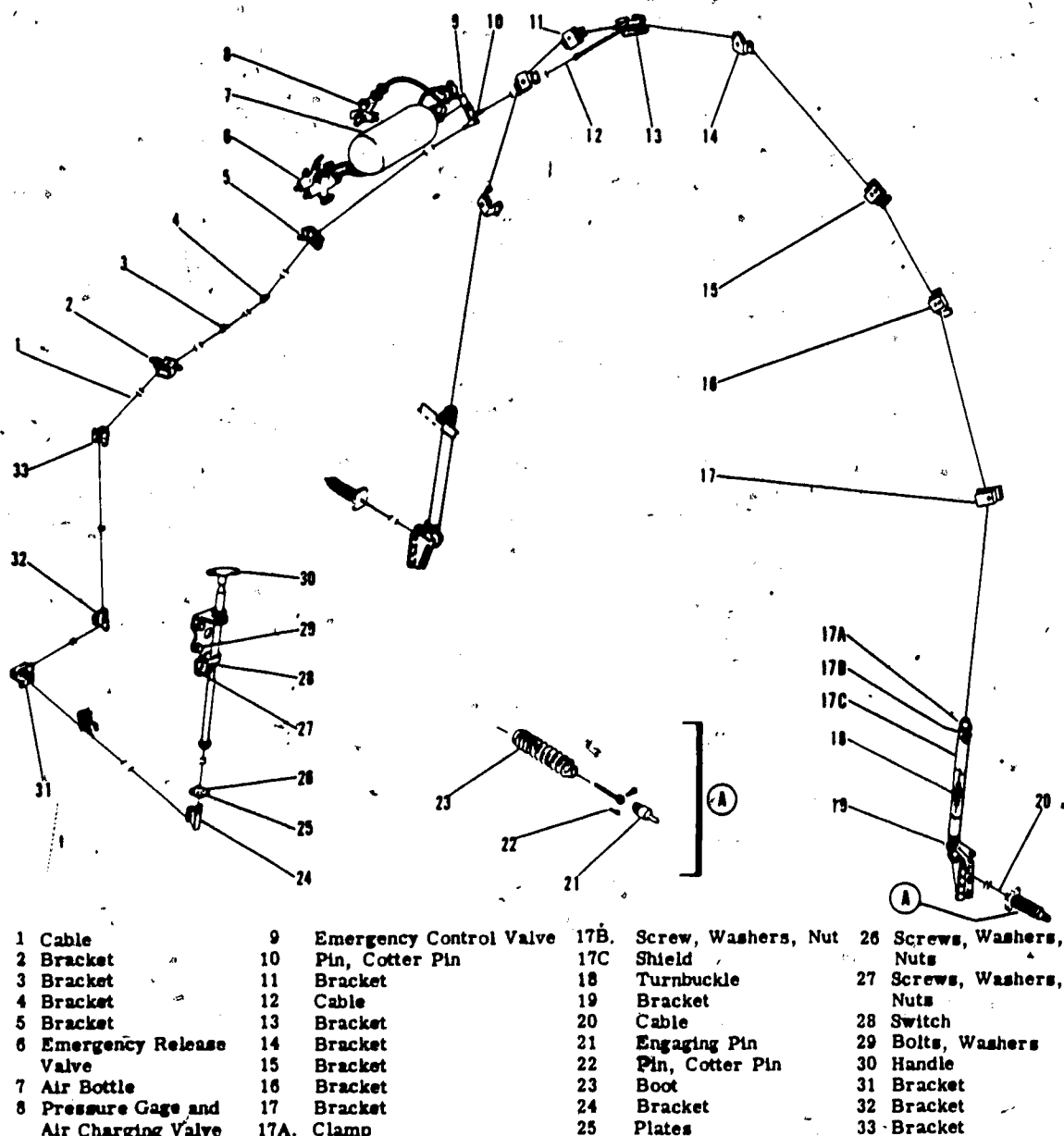


Figure 47. - Landing gear emergency extension system.

of a handle, cables, pulleys, and pins. The release handle is on the left side of the center console in the cockpit. Cabling connected to the handle extends through the pulleys to the pin in the uplock mechanism in each sponson and to the air bottle on the right side of the transmission well.

Emergency Control Valve And Air Bottle

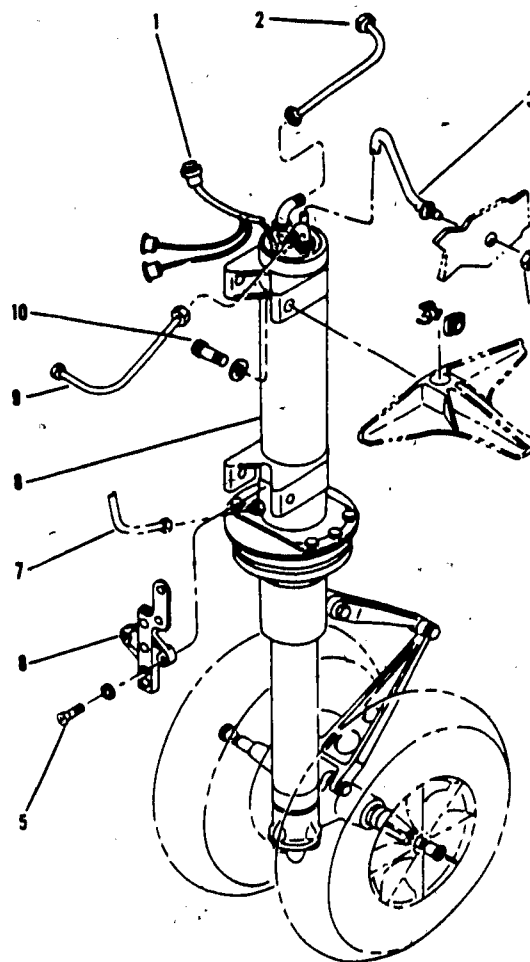
(See figure 47.) A pressurized air bottle (figure 46, item 7) and emergency control valve (9) are in the transmission well on the right side of the helicopter. Actuating the valve releases compressed air to the main landing gear retracting cylinders to lower the gear in an emergency. At the same time, the compressed air actuates the emergency air valves (6) and the shuttle valve (figure 50, item 14) to vent the hydraulic system to prevent a hydraulic lock. The air bottle is normally charged to 3,000 psi and should be recharged if the pressure drops below 2,500 psi.

Emergency Air Valves

The two air-operated emergency air valves (figure 50, item 2), in the cabin on the right side of the transmission well, vent the nose gear kneeling cylinder and main gear retracting cylinder for emergency extension of the landing gear. The emergency air valves are actuated by air from the air bottle. The solenoid operated emergency release valve, on the left side of the transmission deck, directs hydraulic power to lower the nose gear for emergency extension of the nose gear.

Nose Landing Gear

A retractable nose landing gear (figure 48) is bolted to the forward structure immediately aft of the electronics compartment. The gear consists of a strut, kneeling piston, dual wheels, shimmy damper, and nose gear lock control system. It is retracted vertically into the fuselage for flight and may be kneeled to provide additional overhead clearance when cargo is being loaded through the rear ramp. The



- | | |
|-----------------|--------------------------------|
| 1 Cable | 7 Upline Tube |
| 2 Downline Tube | 8 Nose Landing Gear |
| 3 Vent Line | 9 Return Line Tube |
| 4 Nut | 10 Bolt, Washer, Retainer, Nut |
| 5 Screw, Washer | |
| 6 Pin Guide | |

Figure 48. - Nose landing gear.

Wheel can swivel 360 degrees and may be locked in the trailing position by the lock control system.

Shock Strut

The shock strut consists of a cylinder and a kneeling piston to extend and retract the nose gear. Also, the shock strut consists of dual wheels, a shimmy damper, and microswitches to light the control handle when the nose gear is cycling, and to light

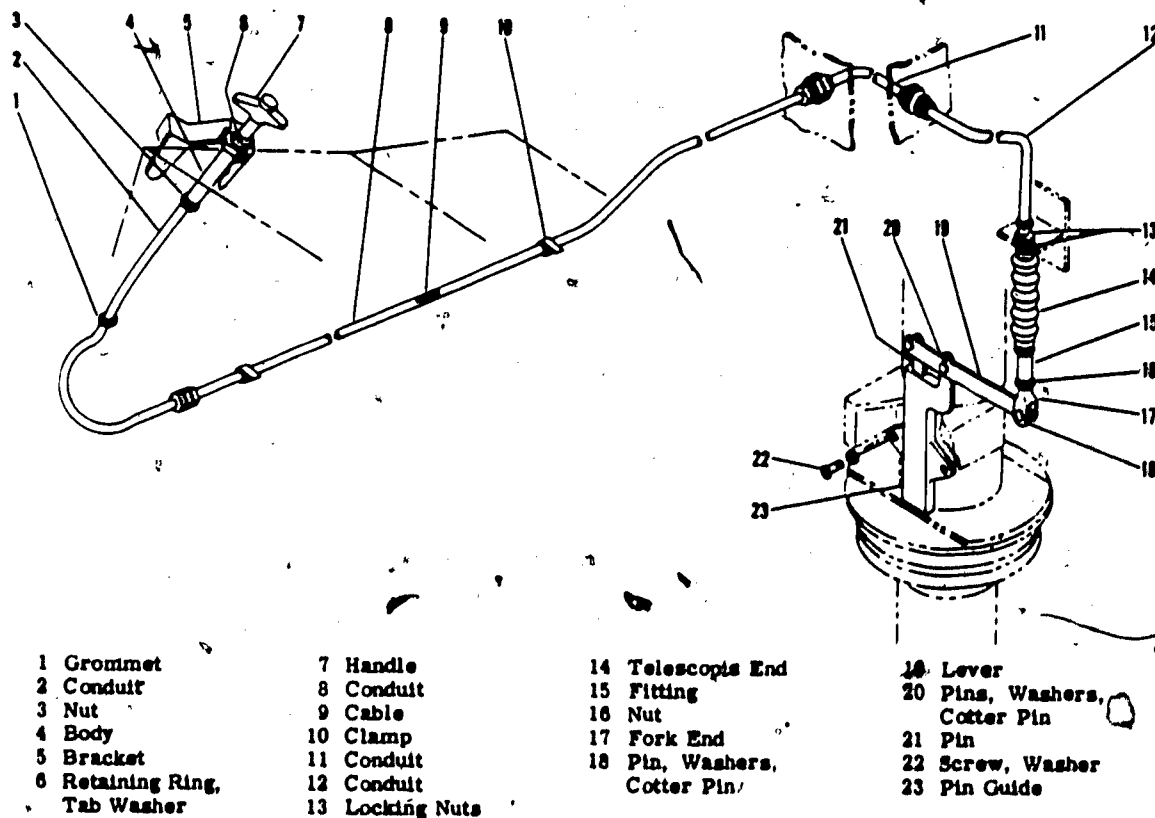


Figure 49. - Nose gear lock control system.

the NOSE GEAR DOWN indicator light on the control unit. Two adapters are secured to the axle so the helicopter may be towed forward. The shimmy damper dampens gear oscillations and ground disturbances that occur when the helicopter is taxiing.

Nose Gear Lock Control System

The nose gear lock control system (figure 49) consists of a handle marked PARK LOCK secured to the right side of the center

console; a pin guide secured to the nose landing gear shock strut above the shimmy damper; a pin in the guide; a lever connected to the pin and pin guide; and a cable. The cable is connected between the handle and lever. When the handle is pulled, aft and up, the cable lifts the arm attached to the pin guide. This pushes the pin into a slot in the shock strut flange, locking the nose landing gear in the straightforward position. When the handle is pulled aft and pushed down, the pin is withdrawn from the slot, allowing the nose landing gear to swivel.

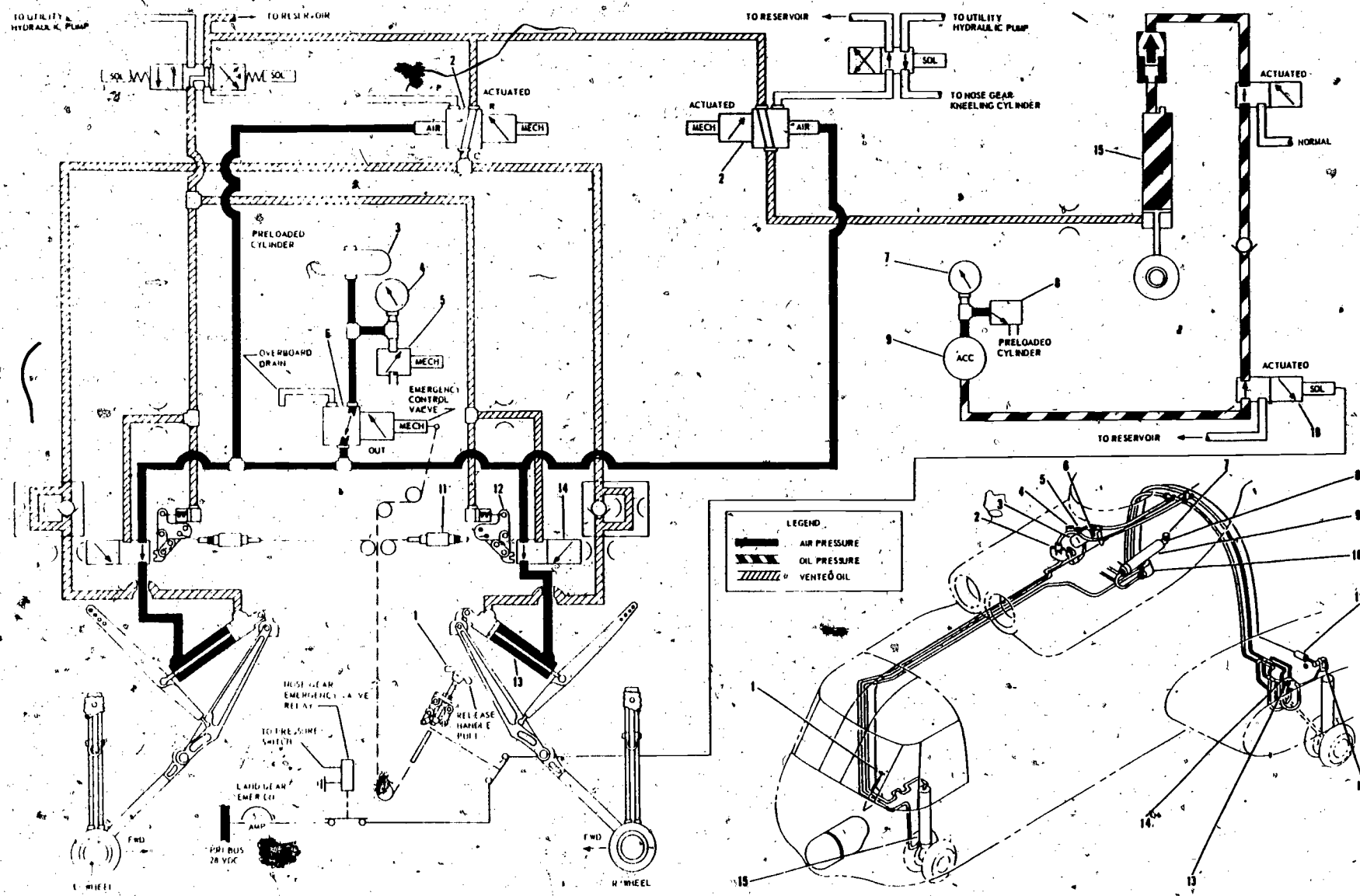


Figure 50. - Landing gear emergency extension system - schematic diagram.

REVIEW

This section has given you a good background on the utility hydraulic system and the landing gear system. As a flight mechanic on the HH-3F, you will need to know these systems in detail.

(Now answer the following review questions.)

30. The utility hydraulic system operates at _____ psi pressure. 30.-D (Refer to page 55)

- A. 750
- B. 1,500
- C. 1,750
- D. 3,000

31. The external pressure coupling is protected from back pressure by a _____. 31.-B (Refer to page 56)

- A. snubber
- B. check valve
- C. relief valve
- D. control valve

32. The flow of oil either through or around the oil cooler is controlled by a _____ valve. 32.-D (Refer to page 58)

- A. check
- B. diverter
- C. pressure bypass
- D. thermostatic bypass

33. Refer to figure 42 in your text, which components are contained schematically within the same component? 33.-C (Refer to page 59)

Relief valve (4)
Control valve (5)
Snubber (6)
Filter (7)
Transmitter (9)
Heat exchanger (13)

- A. 5, 7, 9
- B. 4, 5, 13
- C. 4, 5, 6, 7
- D. 6, 7, 9, 13

34. The pressure lock valve must be energized to _____. 34.-A (Refer to page 61)

- A. raise the nose gear
- B. raise the main gear
- C. lower the nose gear
- D. lower the main gear

35. In an emergency, the main landing gear is extended by _____.

35.-B (Refer to page 66)

- A. an electric motor
- B. air pressure
- C. trapped hydraulic pressure
- D. a mechanical jackscrew

36. The light in the landing gear control handle will be illuminated when the gear is _____.

36.-D

This light serves as a warning that the landing gear is not in a fully up or down position. (Refer to page 66)

- A. up and locked
- B. down and locked
- C. up and the throttle is retarded
- D. in any intermediate position between full up or down

37. The main landing gear downlock limit switch is mounted on the _____.

37.-A

This switch gives an indication in the cockpit when the gear is locked down. (Refer to page 67)

- A. retracting cylinder
- B. upper drag link
- C. lower link
- D. upper link

38. What are the functions of the switches mounted on the lower aft end of each main landing gear trunnion?

38.-D

(Refer to page 67 and 68)

1. Release the landing gear handle locking pin
2. Permit the main landing gear to lock in the down position
3. Permit lowering of the forward ramp on the ground
4. Complete the underfrequency control circuit
5. Actuate the UNSAFE GEAR light in the cockpit

- A. 1, 3, and 5
- B. 2, 3, and 4
- C. 2, 4, and 5
- D. 1, 3, and 4

39. Actuation of the emergency extension release handle does which of the following?

39.-C

(Refer to page 70)

1. Disengages a release pin from the main gear uplock
2. Disengages a release pin from the nose gear uplock
3. Opens the emergency control valve

- A. 1 only
- B. 2 and 3 only
- C. 1 and 3 only
- D. 1, 2, and 3

40. The emergency landing gear air bottle should be recharged when the pressure drops to _____ psi.

40.-C (Refer to page 72)

- A. 1,500
- B. 2,000
- C. 2,500
- D. 3,000

41. The nose wheel can swivel a MAXIMUM of _____ degrees.

41.-D (Refer to page 72)

- A. 70
- B. 90
- C. 180
- D. 360

WHEEL BRAKE, RAMP, AND RESCUE HOIST SYSTEMS

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the wheel brake system.
2. Identify the wheel brake system components and explain their function.
3. Summarize the ramp system.
4. Identify the components of the ramp system and explain their function.
5. Summarize the operation of the hoist system.
6. Distinguish between the components of the hoist system and define them.

WHEEL BRAKE SYSTEM

The main wheel brake system (figures 51 and 52) consists of four master cylinders, two slave mixer valves, a parking brake valve, a parking brake handle, and two dual-wheel brakes. When the pilot's or copilot's pedals are depressed, hydraulic pressure builds up in the master cylinder. The pressurized hydraulic fluid flows from the master cylinder through the slave mixer valves and the parking brake valve to each dual brake. Two slave mixer valves select which side, pilot's or copilot's, of the dual system will operate the brakes. If pressure from the pilot's side reaches the slave mixer valves first, the valves act to check fluid flow from the copilot's side. Therefore, only the pilot or copilot may operate main wheel brakes during a given moment. The parking brake valve is actuated by the parking brake handle on the right side of the center console. When actuated, the parking brake valve traps fluid pressure to the brakes. The parking brake is released by depressing the toe pedals. This action produces pressure in the master cylinder which actuates the parking brake valve release mechanism.

EQUIPMENT COMPONENTS

Brake Pedals

The brake pedals, on the pilot's and copilot's directional control pedals, pivot

on needle bearings and are held in place by split washers set in grooves. The master cylinder piston is attached to a stud secured in the pedal. The main landing gear wheel brakes are individually actuated by depressing the corresponding toe brake pedal.

Slave Mixer Valves

Two slave mixer valves (figure 52 item 2) are in the brake lines between the pilot's and copilot's master brake cylinders and main wheel brakes. The valves check and shuttle pressure flow from master brake cylinders to the main wheel brakes. This allows independent brake application by the pilot or copilot and prevents simultaneous dual operation of the brakes. The slave mixer valve piston is spring-loaded open to the pilot's master brake cylinders. Pressure from the copilot's cylinders will shuttle the piston in the mixer valve to create pressure to the main wheel brakes.

Master Brake Cylinder

The master brake cylinders (figure 53) are secured to the tail rotor control pedals. The cylinders provide hydraulic pressure for braking the helicopter. Pressing the toe brake pedals actuates the pistons in the master brake cylinders. Cylinder pistons force hydraulic fluid from the master cylinder under pressure to operate the wheel brakes.

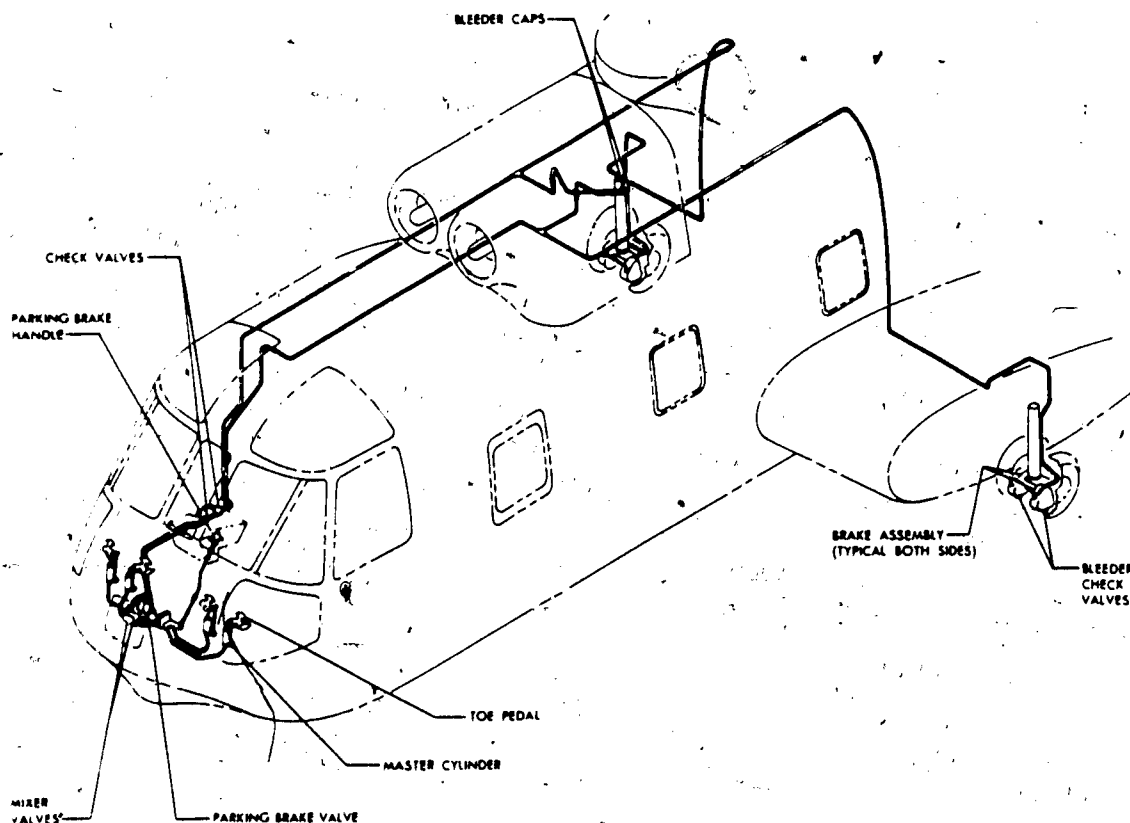


Figure 51. - Wheel brake system - Component location diagram.

Brake

(See figure 54 and 55.) Each brake is a single cavity, self-adjusting disc-type brake. Braking action is provided by hydraulically clamping the brake disc between the piston lining and anvil linings retained in the brake housing. The anvil linings are stationary, but the piston linings are hydraulically operated.

Parking Brake Valve

The mechanically operated valve (figure 56), in the brake lines between the master cylinders and wheel brakes, traps hydraulic fluid pressure to the wheel brakes. When actuated by the parking brake handle, a cam in the valve turns to block the ports to the master cylinders and opens ports to the accumulators. The accumulators are spring-loaded valves which compensate for oil volume changes due to tempera-

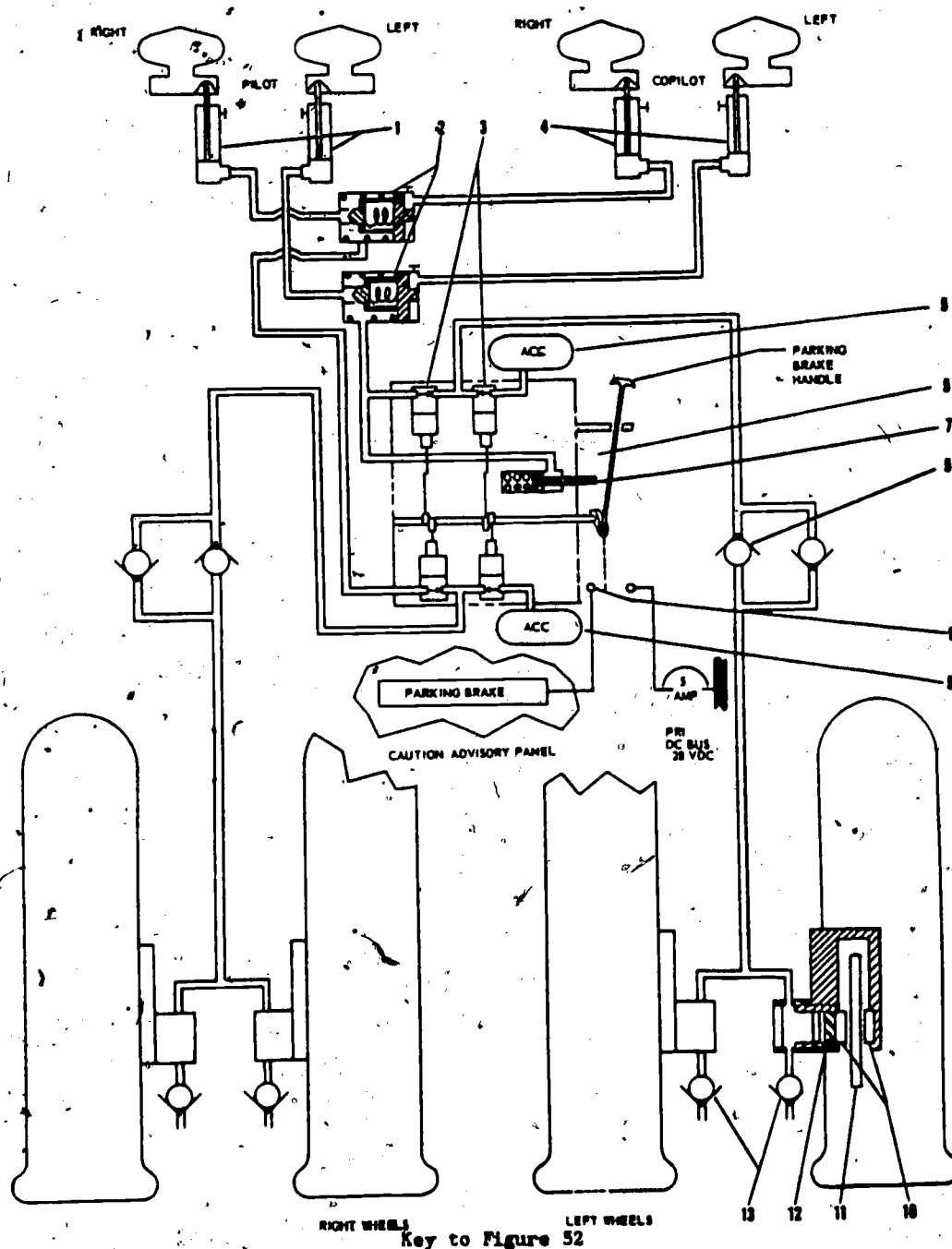
ture variations. In the off position, hydraulic fluid freely flows through the valve. Access to the valve is through the nose door.

Parking Brake Handle

The parking brake handle, on the right side of the center console, is a straight pull type. The parking brake is set by depressing the brake pedals and holding the PARKING BRAKE handle up until the brake pedals are released. The PARKING BRAKE handle is released by applying brake pedal pressure. Brake handle operation actuates the parking brake valve switch, which illuminates a green PARKING BRAKE capsule on the caution/advisory panel.

RAMP SYSTEM

The ramp system (figure 60) consists of the forward and aft ramps, ramp cylinders, uplock cylinders, control valves,



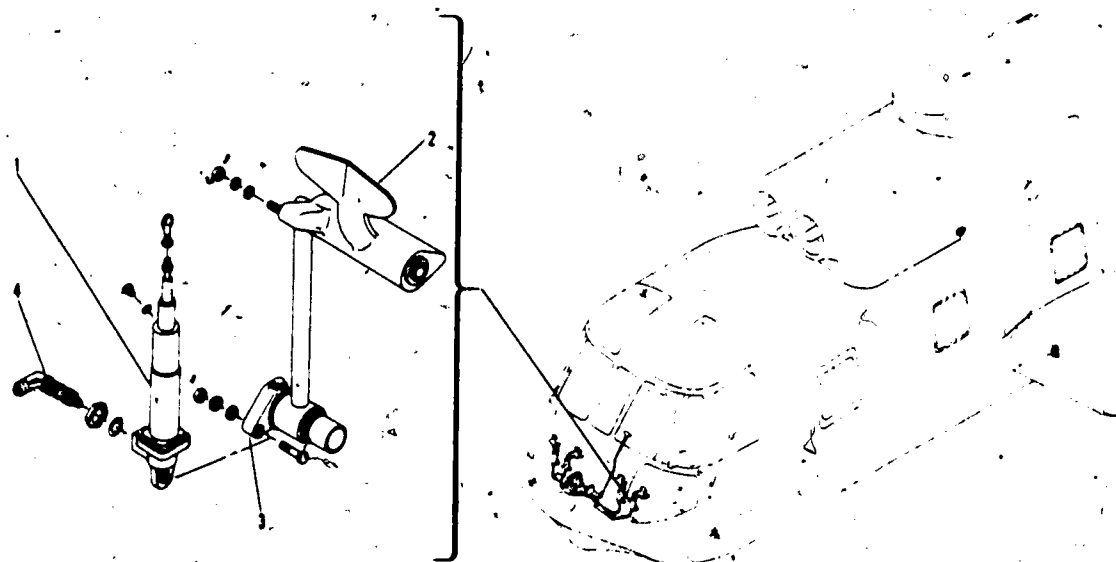
Key to Figure 52

- | | | |
|----------------------------|-----------------------|------------------|
| 1 Pilot's Master Cylinders | 6 Parking Brake Valve | 10 Brake Linings |
| 2 Mixer Valves | 7 Release Pin | 11 Brake Disc |
| 3 Sequence Valves | 8 Check Valve | 12 Piston |
| 4 Accumulator | 9 Switch | 13 Check Valves |
| 5 Accumulator | | |

Figure 52. - Wheel brake system - schematic diagram.

indicating lights, cables, a cockpit ramp control panel, and a crew ramp control panel. The MASTER switch on the cockpit RAMP

CONTROL panel completes an electrical circuit to either the cockpit RAMP CONTROL panel or crew RAMP CONT panel. When the



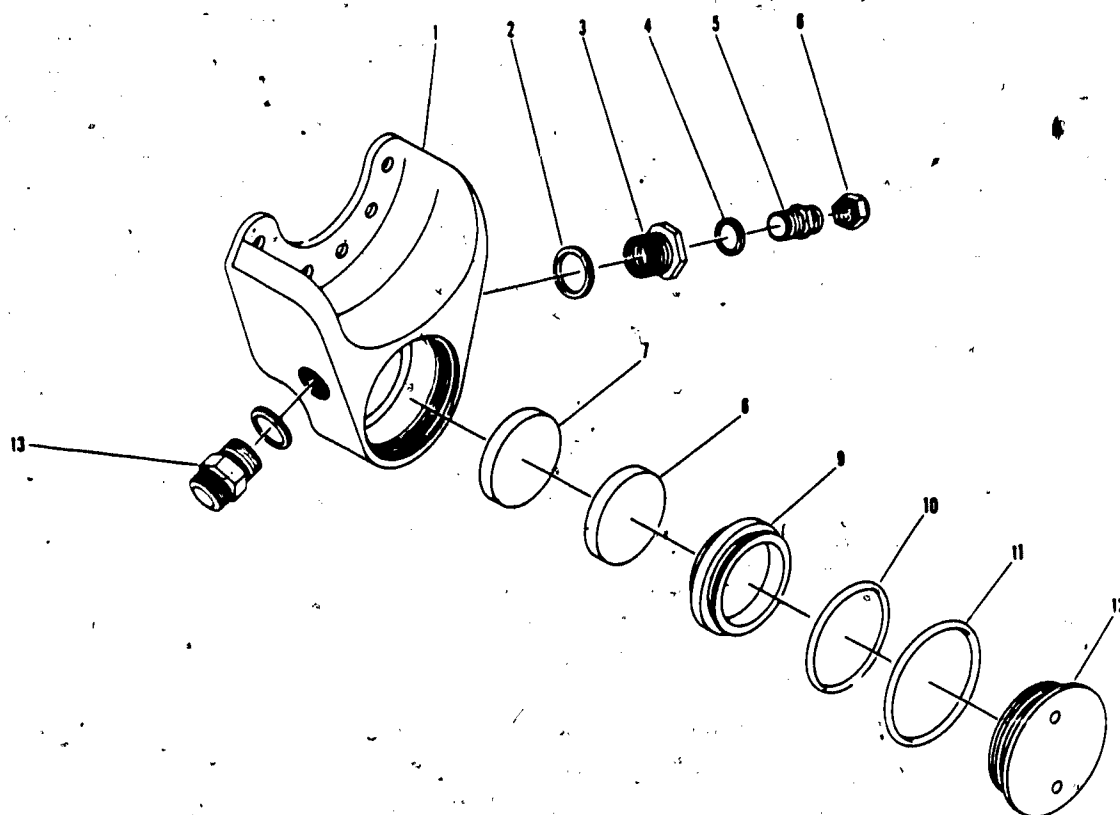
1 Master Brake Cylinder

2 Toe Brake Pedal

3 Arm

4 Elbow, Nut, Gasket

Figure 53. - Master brake cylinder.



1 Brake Housing

2 Gasket

3 Bushing

4 Gasket

5 Check Valve

6 Cap

7 Brake Lining

8 Brake Lining

9 Piston

10 Seal

11 Seal

12 Cylinder Head

13 Union, Gasket

Figure 54. - Wheel brake.

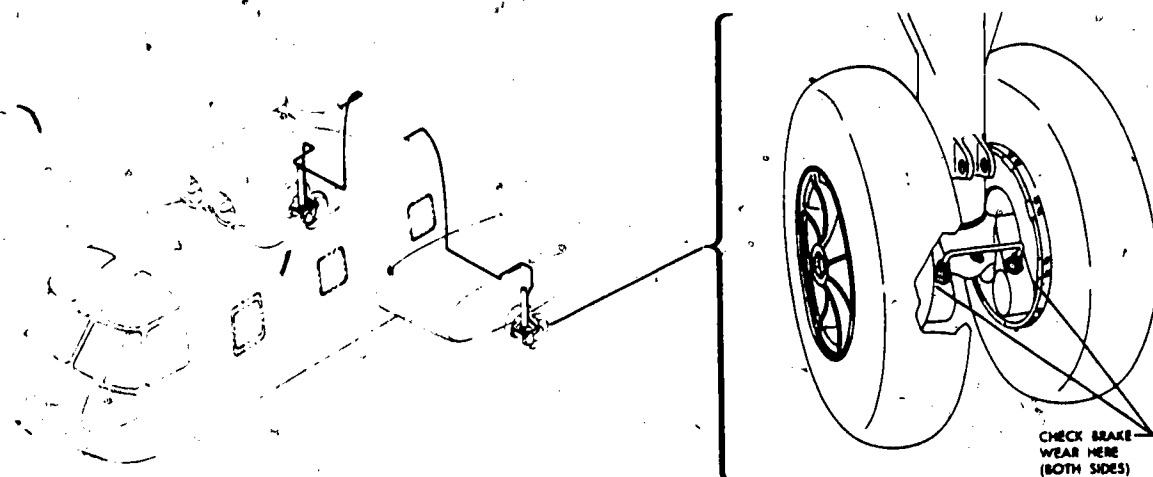


Figure 55. - Checking brake wear.

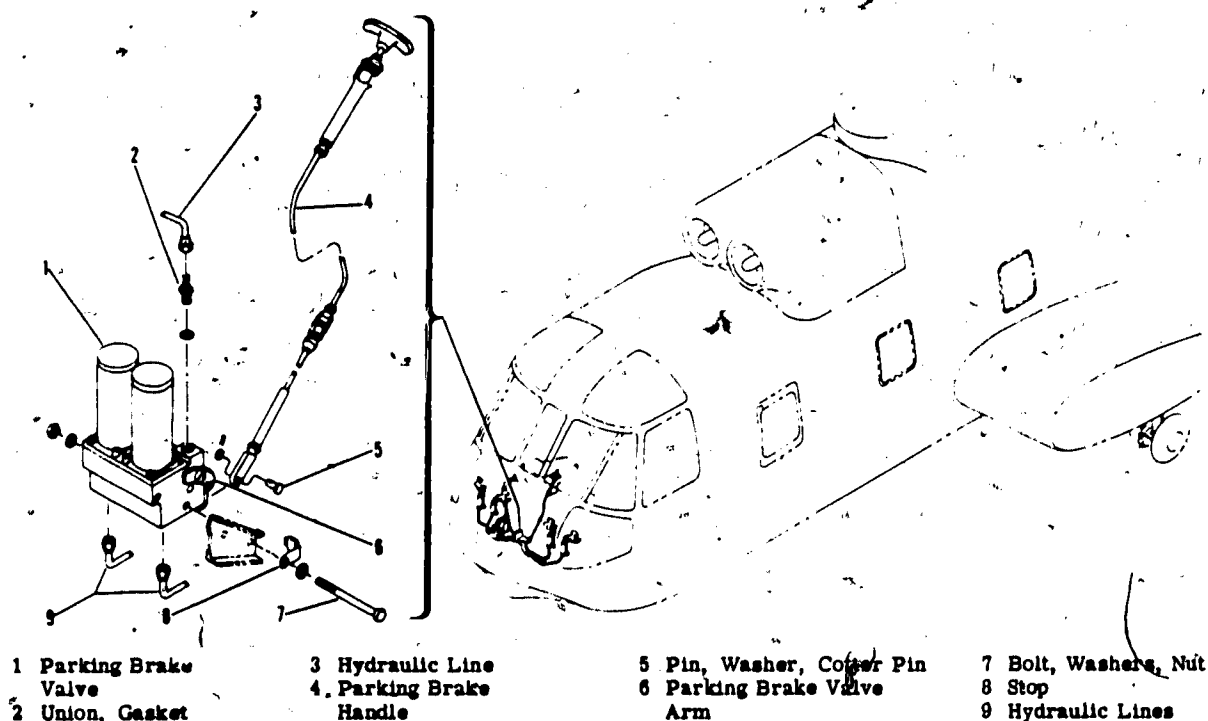


Figure 56. - Parking brake valve.

AFT RAMP switch on either panel is positioned to OPEN, an electrical circuit is completed to the solenoid in the downside of the aft ramp control valve (17). When the solenoid valve is actuated, hydraulic pressure through the valve actuates the ramp uplock cylinder (7) to unlock the ramp, and actuates the aft ramp cylinders (10) to lower the ramp. The ramp UP-LIMIT switch is tripped, de-

energizing the forward ramp interlock relay to complete a potential circuit from the OPEN contact of the FWD RAMP switch to the solenoid of the forward ramp control valve (3), so the forward ramp may be opened. Also, a circuit is completed to the RAMP light on the caution/advisory panel and to the AFT RAMP OPEN indication lights on both ramp control panels.

When the AFT RAMP switch on either panel is positioned to CLOSE, an electrical circuit is completed to the solenoid of the upside of the aft ramp control valve, and the aft ramp interlock relay becomes energized. When the solenoid is actuated, hydraulic pressure through the valve actuates the aft ramp cylinders to close the aft ramp. When the ramp is fully up, power to the RAMP light on the caution/advisory panel and to the AFT RAMP OPEN indicating lights on both ramp control panels is disrupted by the energized aft ramp interlock relay, and the forward ramp interlock relay is energized. The relay prevents opening the forward ramp, unless the aft ramp is open, by disrupting power to the solenoid of the down side of the forward ramp control valve.

When the aft ramp is open, positioning the FWD RAMP switch on either ramp control panel to OPEN completes an electrical circuit to the solenoid of the downside of the forward ramp control valve. When the solenoid is actuated, hydraulic pressure through the valve actuates the forward ramp cylinders to open the ramp and close the contacts of an internal switch in the forward ramp cylinders, illuminating the RAMP light on the caution/advisory panel and the FWD RAMP OPEN indicating lights on both ramp control panels.

When the FWD RAMP switch on either panel is positioned to CLOSE, an electrical circuit is completed to the solenoid of the upside of the forward ramp control valve. When the solenoid is actuated, hydraulic pressure through the valve actuates the forward ramp cylinders to close the forward ramp and open the contacts of the internal switch, interrupting power to the RAMP light on the caution/advisory panel and to the FWD RAMP OPEN indicating lights on both ramp control panels.

In flight, safety cables are attached to the aft ramp to hold the ramp in a horizontal position. If the aft ramp strikes a ground obstacle, it will stay at the new position because one side of the ramp cylinders is open to return. When the aft ramp is being opened, hydraulic pressure positions a shuttle valve (9) to direct pressure to the aft ramp uplock cylinders to unlock the aft ramp. Pressure is also directed to the aft ramp cylinders (10) to lower the aft ramp. When the aft ramp is being closed, hydraulic pressure is directed to

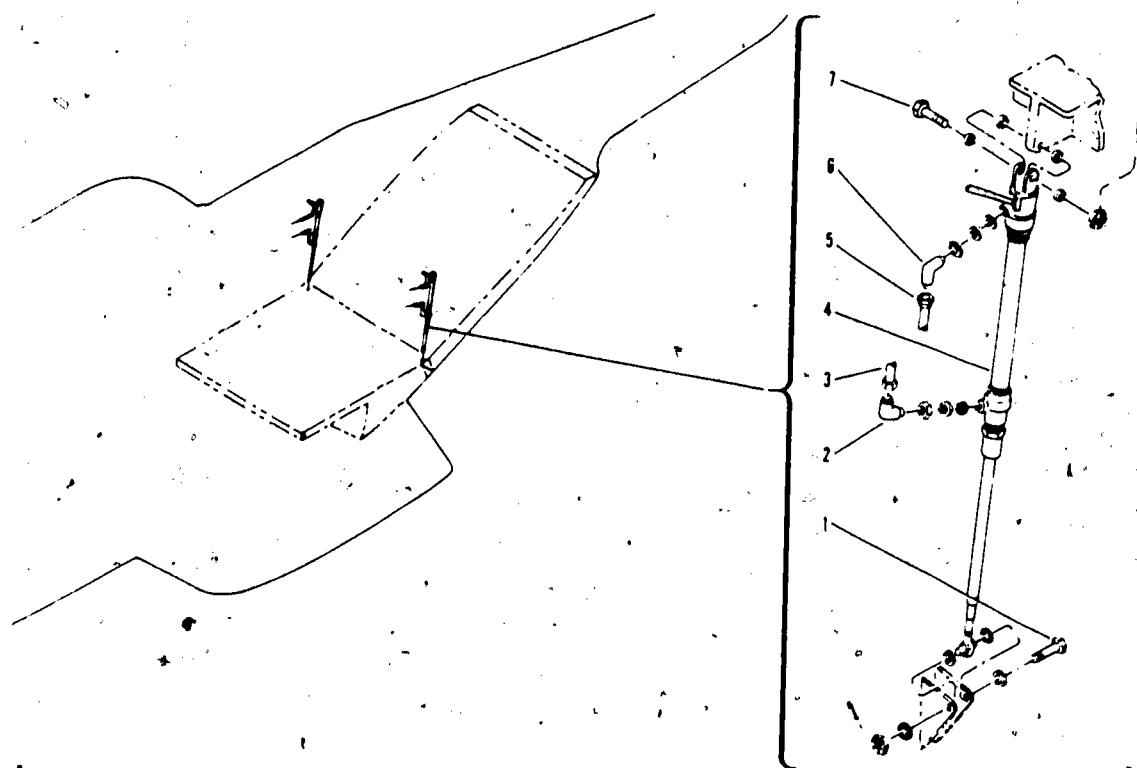
the aft ramp cylinders to close the ramp. Hydraulic pressure also repositions the shuttle valve to direct pressure to the aft ramp uplock cylinders to keep the uplock cylinders unlocked until the aft ramp is closed. The aft ramp uplock cylinders are hydraulically released and mechanically latched. The forward ramp cylinders incorporate uplocks which lock the ramp in the closed position. The uplocks are mechanically latched and released by hydraulic pressure. Restrictors are in the forward and aft ramp hydraulic systems to control the rate at which the ramps open and close.

In the event of an electrical or hydraulic failure, the aft ramp may be opened manually. To open the aft ramp manually from inside the helicopter, pull the handle attached to the manual shutoff valve forward. When the handle is positioned forward, the manual shutoff valve (15) is actuated to vent the aft ramp cylinders, and a cable attached to the handle (5) actuates a handle attached to the uplock cylinder to unlock the aft ramp. The ramp will open by its own weight. The aft ramp may be opened from outside the helicopter by removing the handle from the stowage container secured to the aft fuselage and pulling the handle down. The outside handle is connected by a cable to the handle attached to the manual shutoff valve. The forward ramp may be opened by simultaneously pulling up on the manual override handles on top of the forward ramp cylinders. The ramp will open by its own weight, and the rate of opening will be controlled by a restrictor. Hydraulic power for the ramps is supplied by the utility hydraulic system at 3,000 psi pressure.

EQUIPMENT COMPONENTS

Ramp

The ramp (figure 57), which consists of a forward and aft ramp, permits easy loading of personnel, wheeled vehicles, and cargo. The forward ramp, when lowered, acts as a loading ramp and, when closed, increases cargo capacity by becoming a part of the floor. The aft ramp, when opened, acts as a loading ramp and, when secured in a horizontal position by safety cables, permits transportation of cargo too long to fit in the cabin. The forward ramp cannot



- | | | | |
|----------------------------------|-------------------------|----------------------------|----------------------------------|
| 1 Bolt, Washers, Nut, Cotter Pin | 3 Upline Hose | 5 Downline Hose | 7 Bolt, Washers, Nut, Cotter Pin |
| 2 Elbow, Nut, Ring, Gasket | 4 Forward Ramp Cylinder | 6 Elbow, Nut, Ring, Gasket | |

Figure 57. - Forward ramp cylinder.

be opened unless the aft ramp is opened. The aft ramp may be opened while the helicopter is in the air, on the ground, or while afloat. When the aircraft is airborne or on the water, the forward ramp cannot be opened. In the event of hydraulic or electrical malfunction, the aft ramp may be opened by manual operation of a handle inside the cabin, or from a handle secured to the underside of the aft fuselage. In the event of hydraulic or electrical malfunction, the forward ramp may be opened by manual operation of a manual override handle on each forward ramp cylinder. Ramp operation is controlled by the cockpit and crew ramp control panels.

Forward Ramp Cylinders

The forward ramp cylinders (figure 57), mounted vertically within the aft fuselage section, are attached to fittings on the aft outboard sides of the forward ramp and to fittings on the aft fuselage section. The

forward ramp cylinders open and close the forward ramp when actuated by hydraulic pressure. In the event of hydraulic failure, the cylinders may be actuated to lower the forward ramp by operation of the manual override handle on each cylinder.

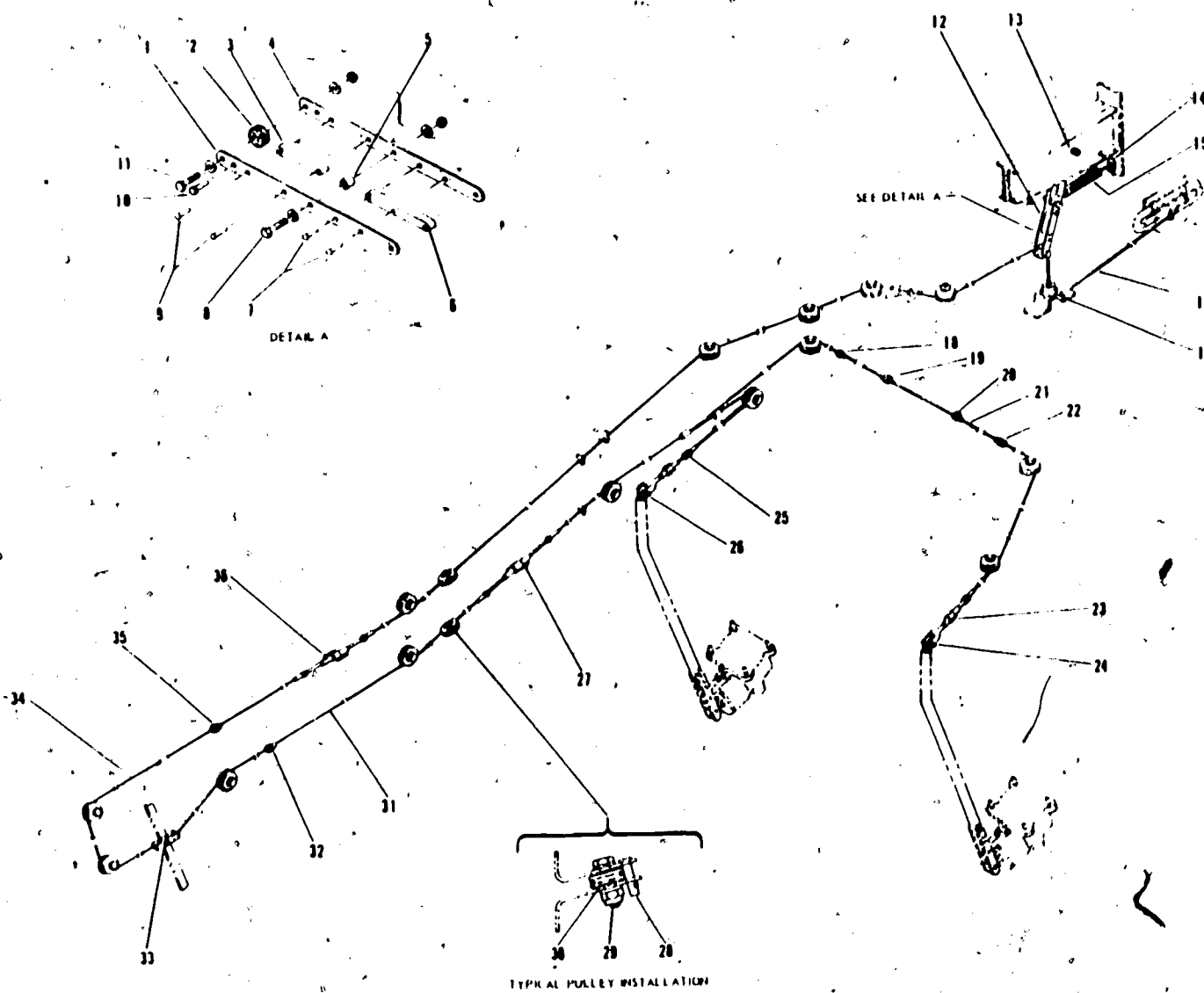
Aft Ramp Cylinders

The aft ramp cylinders (figure 60, item 10), mounted horizontally in the forward ramp and connected to the forward end of the aft ramp, open and close the aft ramp when actuated by hydraulic pressure. Access to the cylinders is gained through two access covers on the bottom of the forward ramp.

Aft Ramp Uplock Cylinders

The aft ramp uplock cylinders (figure 60, item 7), on each side of the aft fuselage section, unlock the aft ramp when actuated by hydraulic pressure. In event of

83



- 1 Side
- 2 Pulley
- 3 Block
- 4 Side
- 5 Bushing
- 6 Block
- 7 Rivets
- 8 Bolt, Washers, Nut
- 9 Rivets
- 10 Pin
- 11 Bolt, Washers, Nut
- 12 Handle
- 13 Bolt, Washers, Nut
- 14 Bolt, Washers, Nut, Bushing
- 15 Spring
- 16 Cable
- 17 Sleeve
- 18 Sleeve
- 19 Sleeve
- 20 Sleeve
- 21 Cable
- 22 Sleeve
- 23 Turnbuckle, Fork, Clips
- 24 Pin, Washer, Cotter Pin
- 25 Turnbuckle, Fork, Clips
- 26 Pin, Washer, Cotter Pin
- 27 Turnbuckle, Clip
- 28 Pin (Typical)
- 29 Bolt, Washers, Nut (Typical)
- 30 Pulley (Typical)
- 31 Cable
- 32 Sleeve
- 33 Pin, Washer, Cotter Pin
- 34 Cable
- 35 Sleeve
- 36 Turnbuckle, Clips

Figure 58. - Aft ramp manual release system - disassembled.

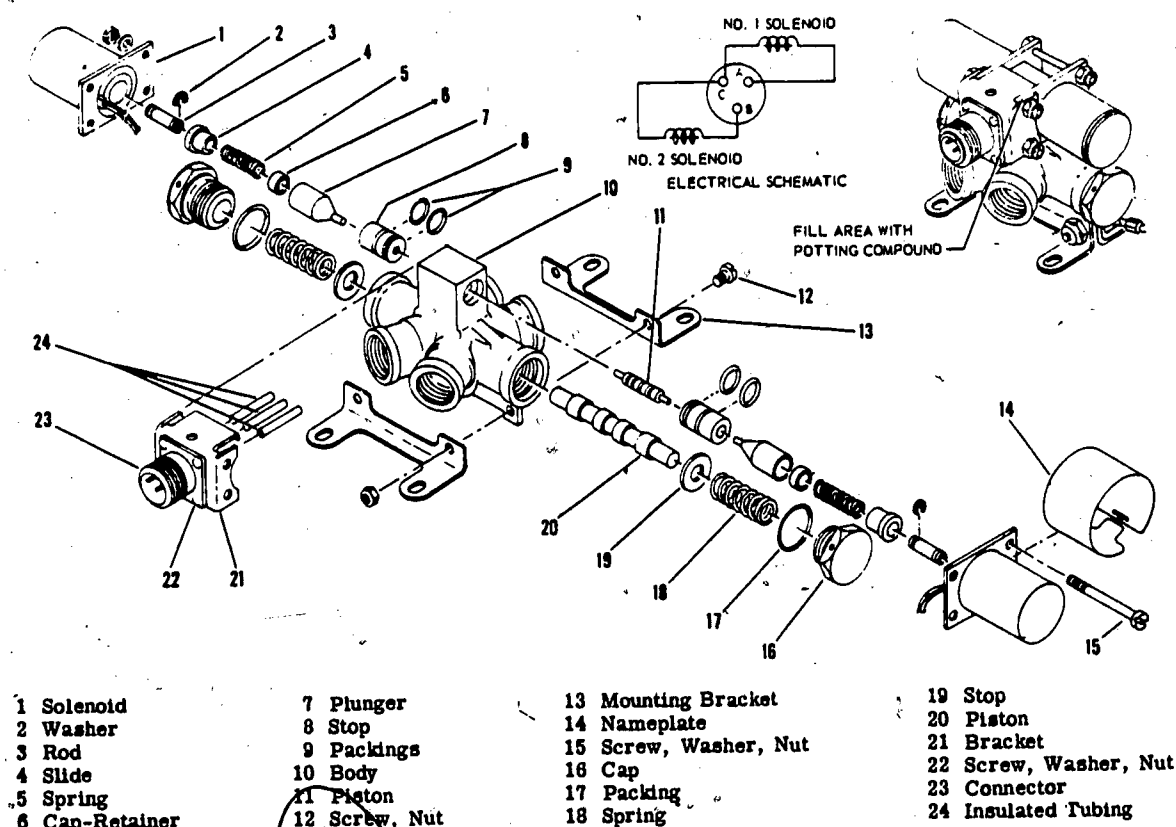


Figure 59. - Ramp control valve.

hydraulic failure, the uplock cylinders may be manually operated by a handle in the cabin or a handle outside the helicopter. The cabin release handle at the manual shutoff valve and the outside release handle in the storage container on the aft fuselage are connected to the handles on the aft ramp uplock cylinders by a system of cables and pulleys.

Aft Ramp Manual Uplock Release System

The manual uplock release handles (figure 59), one on the right internal side of the aft fuselage section and one on the right external side of the aft fuselage section, permit mechanical release of the aft ramp uplock cylinders when electrical or hydraulic power is not available. The external handle is stored under a cover when not in use. When either of the two release handles are actuated, the uplock cylinders are released, a shutoff valve

is actuated to vent the aft ramp cylinders, and the aft ramp will lower by its own weight. A restrictor in the actuating system hydraulic lines provides a snubbing action so the ramp will lower smoothly and slowly.

Aft Ramp Control Valve

The aft ramp control valve (figure 59), on the right cabin wall above the forward ramp, is a four-way solenoid operated valve. When either solenoid of the aft control valve is energized, hydraulic pressure is directed to the aft ramp cylinders to open or close the aft ramp.

Forward Ramp Control Valve

The forward ramp control valve (figure 59), on the right cabin wall above the forward ramp, is a four-way solenoid operated valve. When either solenoid of the valve

is energized, hydraulic pressure is directed to the forward ramp cylinders to open or close the forward ramp.

Check Valves

One check valve (figure 60), is on the tee on the aft ramp control valve. This check valve allows hydraulic pressure to flow to the upline side of the aft ramp cylinder from the aft ramp control valve to close the aft ramp. When the aft ramp is opening, the check valve prevents the aft ramp cylinders from venting directly to the shuttle valve and to the aft ramp control valve. A check valve installed on the bottom tee, between the ramp upline and downline, and aft of the aft ramp control valve allows hydraulic pressure to flow to the upline and downline when the aft ramp is opening. When the aft ramp is closing, the check valve prevents hydraulic pressure entering the downline. A check valve installed on the elbow on the relief valve and the forward ramp upline allows hydraulic pressure from the relief valve to vent to return when the forward ramp is opening. When the forward ramp is closing, the check valve prevents back pressure on the relief valve.

Shutoff Valve

The shutoff valve (figure 60, item 15) is on the right wall above the forward ramp. When the shutoff valve handle is pulled forward, the valve is actuated to vent the aft ramp cylinders. The ramp then can be lowered manually, and the aft ramp will lower under its own weight.

Shuttle Valve

The shuttle valve (figure 60, item 9), on the right wall above the forward ramp, allows hydraulic pressure to release the aft ramp uplock cylinders when the aft ramp is opening. When the aft ramp is closing, the valve is hydraulically repositioned to allow downline hydraulic pressure to maintain the aft ramp uplock cylinders in the unlocked position until the aft ramp is closed.

Relief Valves

A relief valve in the forward ramp system (figure 60, item 4) with a cracking pressure relief of approximately 330 psi is on the right wall above the forward ramp. When the forward ramp is opening, the relief valve allows the forward ramp cylinders to vent hydraulic pressure to the forward ramp control valve. When the forward ramp is stopped by an obstruction in the line during the opening cycle, hydraulic pressure to the forward cylinders is directed through the relief valve to the return line. A relief valve in the aft ramp system with a cracking pressure relief of approximately 3,200 psi is on the right wall above the forward ramp. When the aft ramp is opening, the 3,000 psi hydraulic pressure actuating the aft ramp cylinders opens the relief valve to allow the aft ramp cylinders to vent hydraulic pressure.

Restrictors

Five restrictors (figure 60), three two-way and two one-way, are on the right wall above the forward ramp. The restrictors control the rate-of-speed of ramps during opening or closing and dampen out hydraulic pressure surges.

HOIST SYSTEM

The hydraulically operated system (shown in figures 61 and 63) consists of a hoist, motor, control relay, hoist control panel, accumulator, circuit tester, and pilot and crew control switches. The system receives power from the utility hydraulic system at 3,000 psi and can be controlled from the cockpit or at the crew station at the personnel door. The pilot operates the hoist by positioning the HOIST MASTER switch on the overhead control panel to PILOT, and can extend or retract the cable by operating the HOIST UP/DN switch on the collective control stick grip. When the pilot operates the hoist, the speed of the hoist is limited to 100 feet per minute. To use the rescue hoist crew station, the operator positions the HOIST MASTER switch on the overhead control panel to CREW and rotates the manual speed control valve handle in either the UP or DOWN direction, or he positions the crew

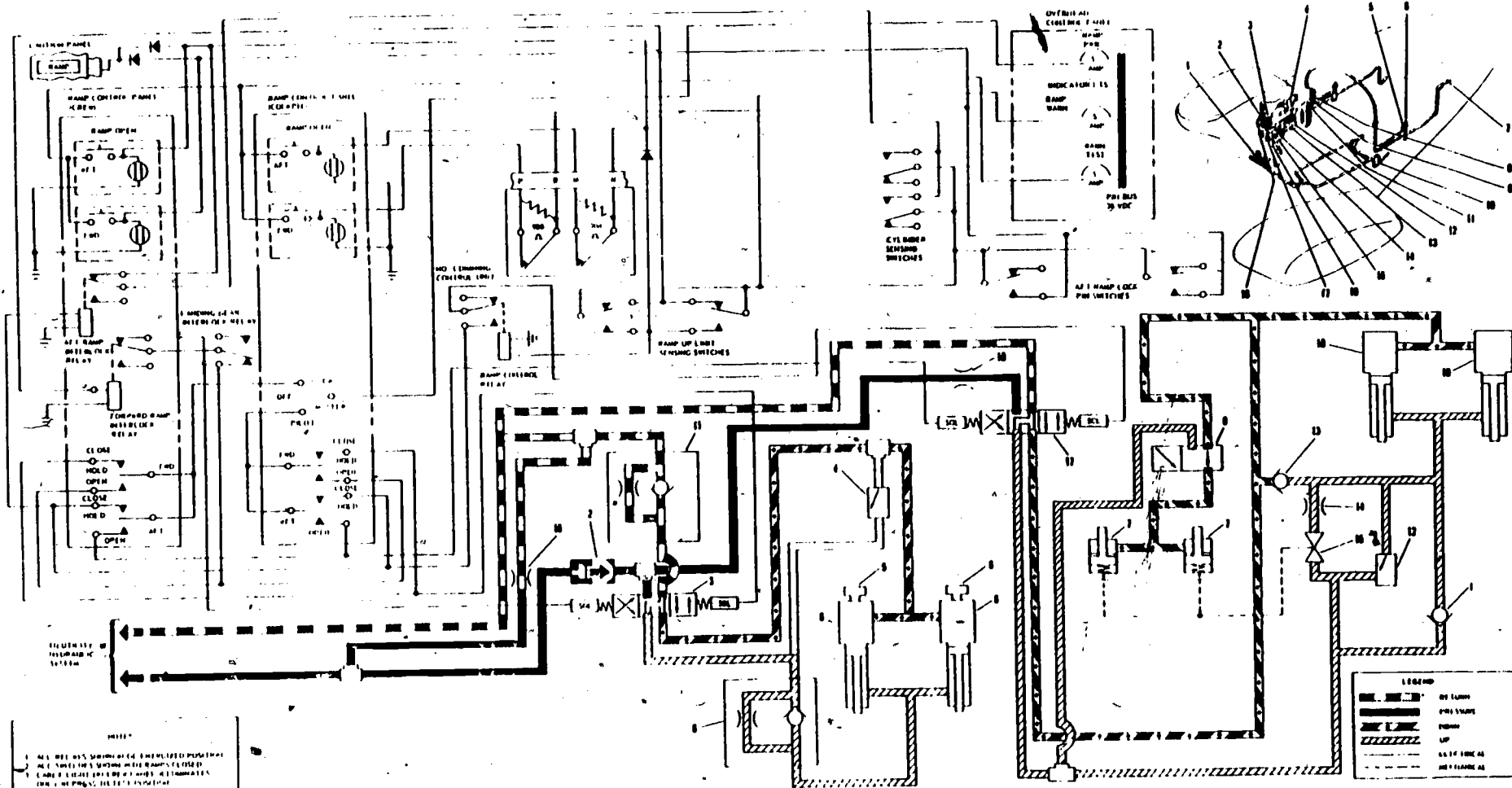


Figure 60. - Ramp system - schematic diagram.

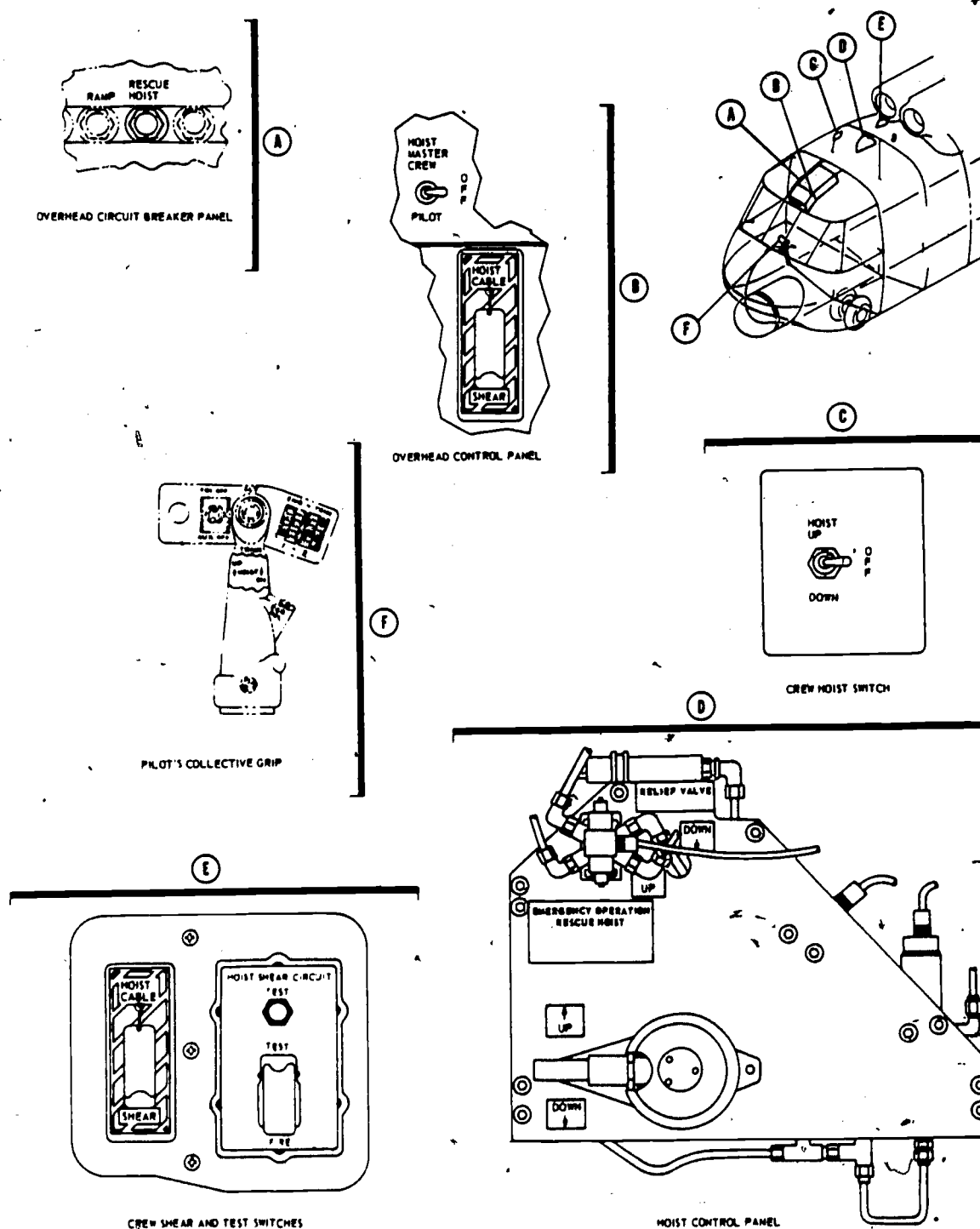


Figure 61. - Rescue hoist - component location diagram.

switch to UP or DOWN. Using the manual speed control valve, the hoist operator can vary the speed of the hoist from 0 to 200 feet per minute, depending upon the amount of

rotation of the handle. Using the hoist crew switch, the operator can operate the hoist at only 100 feet per minute. Limit switches on the hoist stop the hoist at full extend

and full retract. An intermediate switch limits the hoist to a speed of 100 feet-per-minute when 5 to 7 feet of cable remain from the fully extended or retracted position. A built-in guillotine circuit permits shearing of the hoist cable in event of cable ground fouling. Separate HOIST CABLE SHEAR switches exist for the pilot and hoist operator. Faulty wiring in the guillotine circuit can be detected by the circuit tester.

EQUIPMENT COMPONENTS

Hoist

The hoist (figure 63) is installed on a fixed support over the cargo door. Maximum loads are 600 pounds when lifting and 600 pounds when lowering. The hydraulic motor drives the cable drum which can reel in or pay out 240 feet of 3/16-inch diameter corrosion-resistant steel cable. The self-energizing type brake enables the operator to stop the cable at any desired length and hold it in place, with or without a load. The drum and brake housings are partially filled with oil for lubrication and cooling. The level wind mechanism distributes cable evenly on the reel, and limit switches provide automatic stopping of the hoist at extreme upper and lower cable positions. An intermediate limit switch actuates the flow control valve to limit the speed to 100 feet per minute when the cable is about 5 to 7 feet from full extend or retract. A ballistic-type guillotine cartridge permits shearing of the hoist cable in case of emergency. An oil filler hole and sight gage on the hydraulic motor-end of the hoist housing are used for servicing the hoist.

NOTE

Hoists are rated at 550 pounds capacity with a minimum speed of 182 feet per minute.

Hydraulic Motor

The piston-type hydraulic motor on the rescue hoist drives the cable drum to reel in or pay out the hoist cable. The motor is hydraulically driven, at 3,000 psi, by the utility system.

Hook And Handwheel

A hook and handwheel, attached to the hoist cable, serves as a hand grip during rescue operations and as a positive engaging cargo hook.

Hoist Control Panel

The hoist control panel (figures 61 and 62), aft of the personnel door, is incorporated in the rescue hoist system and allows the crewman to operate the hoist at variable speeds. The panel consists of a manual speed control valve, shutoff valve, flow control valve, directional control valve, flow regulators, relief valve, and the necessary hydraulic lines and fittings. DC power for the electrically operated valves is supplied by the DC primary bus through the RESCUE HOIST circuit breaker on the overhead control panel.

Manual Speed Control Valve

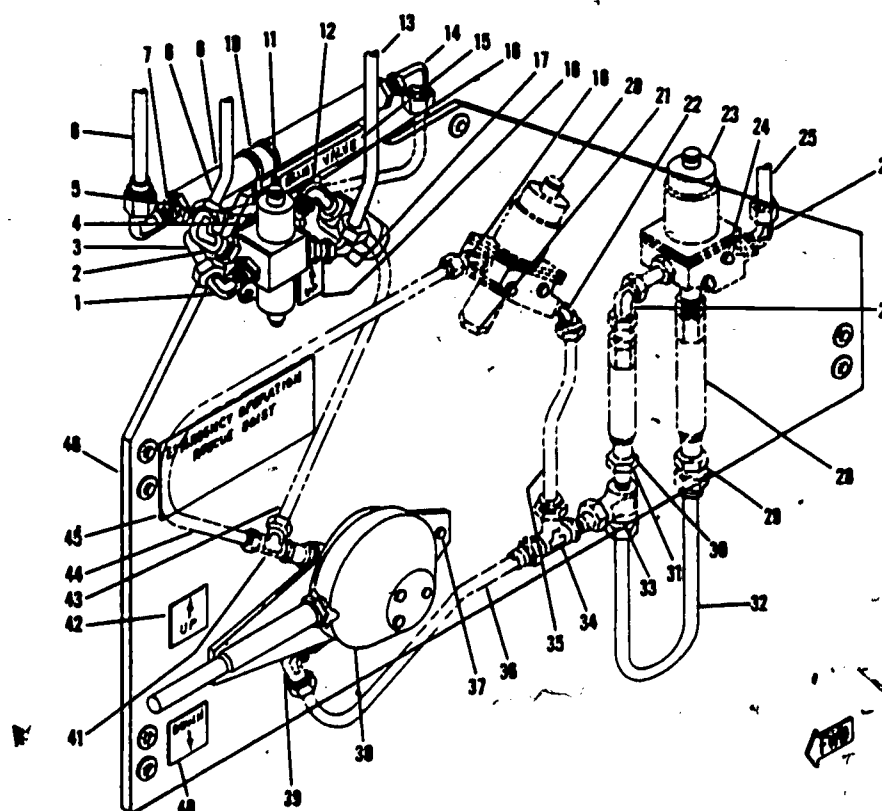
The valve (figure 62, item 38), on the lower forward area of the hoist control panel, is operated manually to vary the speed of the hoist and to select direction of hoist rotation. Positioning the handle to UP or DOWN, up to 90° from center, progressively increases the speed of the hoist by gradually opening the valve. Microswitch contacts in the control, close at 3 to 5 degrees rotation of the handle from center, to direct electrical power to the directional control valve.

Shutoff Valve

The solenoid-operated valve (figure 62, item 20), on the upper, center area of the hoist control panel, provides a bypass around the manual speed control valve to enable the pilot to operate the hoist at a fixed speed.

Flow Control Valve

The three-way solenoid-operated valve (figure 62, item 23), located on the middle



1 Elbow, Nut, Packings	13 Tube	26 Elbow, Nuts, Packings	37 Bolts, Washers, Nuts,
2 Elbow, Nut, Packings	14 Elbow, Nut, Packings	27 Elbow, Union, Nuts,	38 Manual Control Valve
3 Tube	15 Plate	28 Flow Regulator	39 Reducer, Elbow, Nut,
4 Bolts, Washers, Nuts	16 Plate	29 Union, Packing	40 Plate
5 Directional Control Valve	17 Elbow, Nut, Packings	30 Flow Regulator	41 Reducer, Tee, Nut,
6 Tube	18 Plate	31 Union, Packing	42 Plate
7 Elbow, Nut, Packings	19 Elbow, Nut, Packings	32 Tube	43 Tube
8 Tube	20 Shutoff Valve	33 Tee, Nut, Packings	44 Tube
9 Relief Valve	21 Plug, Packing	34 Tee, Nut, Packings	45 Plate
10 Clamp	22 Elbow, Nut, Packing	35 Tube	46 Hoist Control Panel
11 Bolt, Washer, Nut	23 Flow Control Valve	36 Tube	
12 Elbow, Nut, Packings	24 Bolts, Washers, Nuts		
	25 Tube		

Figure 62. - Hoist control panel.

aft area of the hoist control panel, controls hydraulic fluid to the flow regulators.

Flow Regulators

Two flow regulators (figure 62, items 28 and 30), on the hoist control panel, regulate maximum speed of the hoist motor by limiting the flow of hydraulic fluid. When the hoist is operated by the pilot, or with the crew hoist switch, hydraulic

fluid is routed through the low flow regulator, permitting the hoist to operate at 100 feet per minute. When the hoist is operated with the manual control valve, hydraulic fluid is routed through the high flow regulator, permitting the hoist to operate from zero to 200 feet per minute.

Relief Valve

The relief valve (figure 62, item 9), on top of the hoist control panel, has a

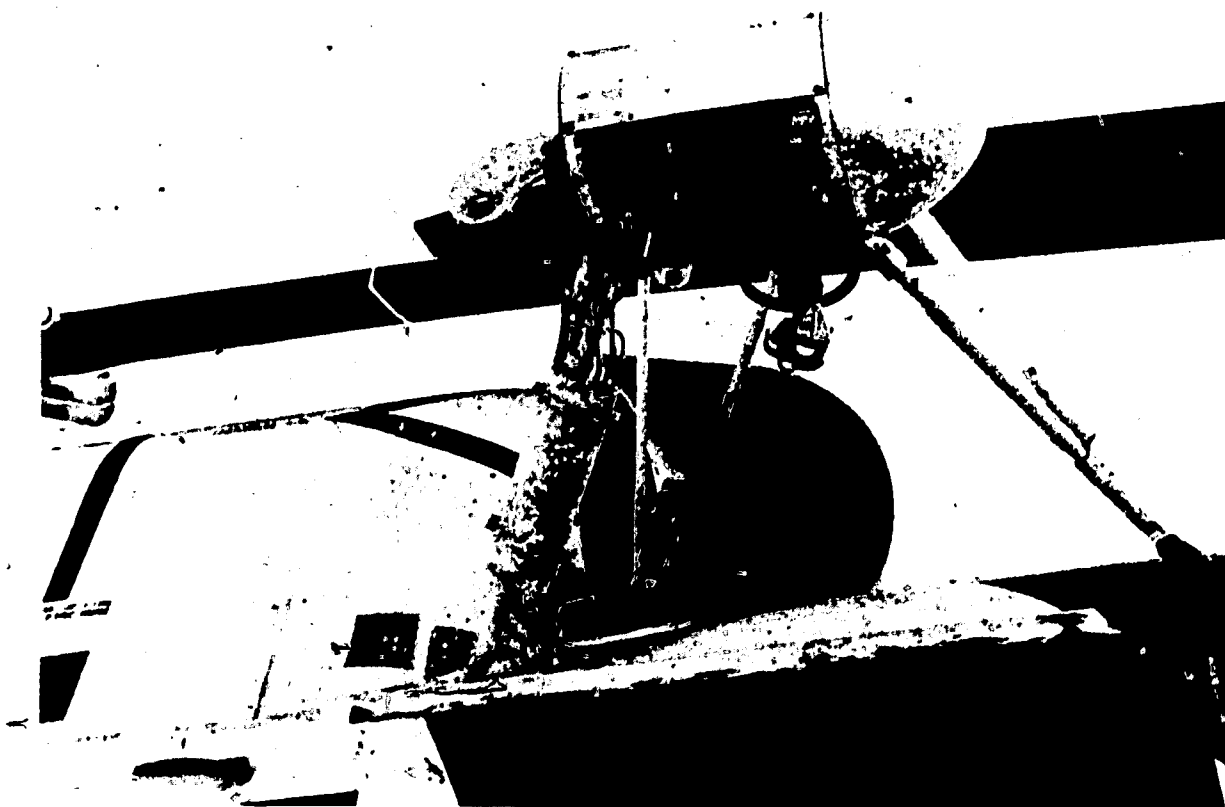


Figure 63. - HH-3F hoist assembly.

225 psi cracking pressure. When the hoist is being extended, the relief valve creates a back pressure in the return line to allow smooth operation of the hoist brake.

Accumulator

An accumulator, on top of the hoist support, maintains constant pressure to ensure the hoist brake disengages during cable extension. The accumulator is charged with 200 psi air pressure.

Restrictor

The restrictor, on the accumulator, regulates the accumulator discharge rate when the hydraulic hoist motor is actuated.

Circuit Tester

The circuit tester, aft of the personnel door, is incorporated in the rescue hoist guillotine circuitry. The circuit tester contains a HOIST SHEAR CIRCUIT TEST switch, marked FIRE and TEST. The circuit tester is used to determine if the guillotine system wiring is faulty.

REVIEW

To complete a preflight/postflight on the HH-3F, the flight mechanic must have a working knowledge of the wheel brake system, the ramp system, and the hoist system. This section was designed to give you this knowledge.

(Now answer the following review questions.)

42. Which statement concerning aircraft brakes is TRUE?

1. The pilot's pedals will operate the brakes
 2. The copilot's pedals will operate the brakes
 3. Both the pilot and the copilot can apply pressure to the brakes simultaneously
 4. The parking brake is released by rotating the release handle 90 degrees
- A. 1 and 2
B. 2 and 3
C. 3 and 4
D. 1 and 3

43. Which of the following serve(s) as a shuttle valve to control brake pressure between the master cylinders and the main wheel brakes?

- A. Sequence valves
B. Mixer valves
C. Master cylinders
D. Parking brake valve

44. In the parking brake system, any pressure buildups due to temperature variations are bled off by the _____.

- A. parking brake valve
B. master cylinders
C. relief valves
D. accumulators

45. Pressurized hydraulic fluid passes through which components when you raise the aft ramp?

1. Shuttle valve
2. Uplock cylinders
3. Mechanical latches
4. Restrictor

- A. 1 and 2 only
B. 3 and 4 only
C. 2, 3, and 4 only
D. 1, 2, 3, and 4

42.-A Two slave mixer valves in the brake lines prevent simultaneous operation of the pilot's and copilot's brakes. (Refer to page 81)

43.-B (Refer to page 81)

44.-D These are spring-loaded valves which compensate for oil volume changes. (Refer to page 82)

45.-D (Refer to page 86)

46. Which statement concerning ramp operation is TRUE?

- A. The forward ramp can be opened in flight
- B. The aft ramp can be opened on the water
- C. The forward ramp must be unlocked before the aft ramp can be opened
- D. The forward ramp can be opened on the water

46.-B (Refer to page 87)

47. When lowered manually, the aft ramp lowers at a slow rate because of a _____ in the system.

- A. check valve
- B. snubber
- C. control valve
- D. restrictor

47.-D (Refer to page 91)

48. Assume that the forward ramp is lowered. If you continue to apply DOWN pressure to the forward ramp, you will _____.

- A. damage the ramp
- B. cause no damage because of a relief valve that cracks at 330 psi
- C. cause the control circuit breaker to pop
- D. cause no damage because of a relief valve that cracks at 3,200 psi

48.-B (Refer to page 92)

49. The rescue hoist system is operated by pressure from which hydraulic system?

- A. Utility only
- B. Auxiliary only
- C. Primary
- D. Either the utility or the auxiliary

49.-A The utility hydraulic system supplies the hoist, ramp and landing gear. (Refer to page 92)

50. The MAXIMUM speed at which the hoist can be operated by using the crew switch is _____ feet per minute.

- A. 100
- B. 182
- C. 200
- D. 240

50.-A (Refer to page 95)

51. Which component controls the maximum speed of the hoist?

- A. Flow control valve
- B. Restrictor
- C. Relief valve
- D. Flow regulator

51.-D This allows a maximum speed of 200 ft. per minute with the manual speed control. (Refer to page 97)

52. The hoist control relief valve has a cracking pressure of _____ psi. 52.-C (Refer to page 98)

- A. 175
- B. 200
- C. 225
- D. 250

AUXILIARY POWER UNIT AND ENGINE FIRE DETECTION SYSTEM

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the auxiliary power unit.
2. Identify and define the components of the APU.
3. Summarize the hydraulic start system of the APU.
4. Describe the APU fire extinguishing system.
5. Summarize the fire detection system.
6. Outline the APU start/run checklist.

AUXILIARY POWER UNIT

The auxiliary power unit (APU) consists of a turbine, hydraulic start motor, drive shaft, clutch, adapter, fuel system, control panel, accumulator, ignition exciter, and electrical wiring (figure 64). The APU enables ground operation of the helicopter's electrical and hydraulic systems. A mechanical drive from the turbine through the adapter drive shaft and clutch to the main gear box rear cover permits operation of the main gear box accessory section. Hydraulic power for starting the APU is supplied by the air-charged accumulator to the hydraulic starter motor. Hydraulic fluid is supplied by the utility hydraulic system fluid tank. Fuel for the APU is drawn from the aft main fuel tank, and consumption of fuel is approximately 76 pounds per hour. Sensing devices for low oil pressure, high turbine exhaust temperature, and overspeed conditions provide automatic shutdown of the APU in case of malfunctions. Electrical power for the APU start circuit is supplied by the DC PRI BUS.

ELECTRICAL OPERATION

The sequence of operations in the APU is controlled by switches and relays in the APU CONTROL panel. The PRI-PUMP warning light illuminates until the prime fuel pressure switch opens at 2 psi. Hydraulic fluid under pressure from the accumulator turns the start motor, cranking the turbine engine. The fuel pump operates as the turbine

is being cranked. When fuel pressure reaches 110 psi, the fuel pressure switch opens. When the turbine has accelerated to 90 percent of its rated speed, the 90 percent speed switch opens. At this time the start valve closes, the start fuel valve closes, the ignition unit is de-energized, and the APU is operating. The turbine is shutdown automatically under conditions of low oil pressure, overspeed, or high exhaust temperature. The oil pressure switch will open at pressures of less than 6 psi. Similarly, the 110 percent speed switch will open at speeds in excess of 110 percent of rated speed. Exhaust temperature is monitored by the thermal switch.

TURBINE ENGINE

The centrifugal flow-type turbine engine, rated at 65 to 70 horsepower, consists of a turbine, combustor, reduction drive, accessory section, and associated wiring and plumbing. The turbine and combustor generate torque necessary to sustain engine operation and to power the reduction drive and accessory section. The reduction drive, through an arrangement of gears, provides the necessary shaft speeds for generator and main gear box accessory operation. The accessory section of the turbine engine, mounted on the reduction drive, contains components necessary for engine operation and control. The turbine engine incorporates an integral lubrication system: the supply is contained in the reduction drive.

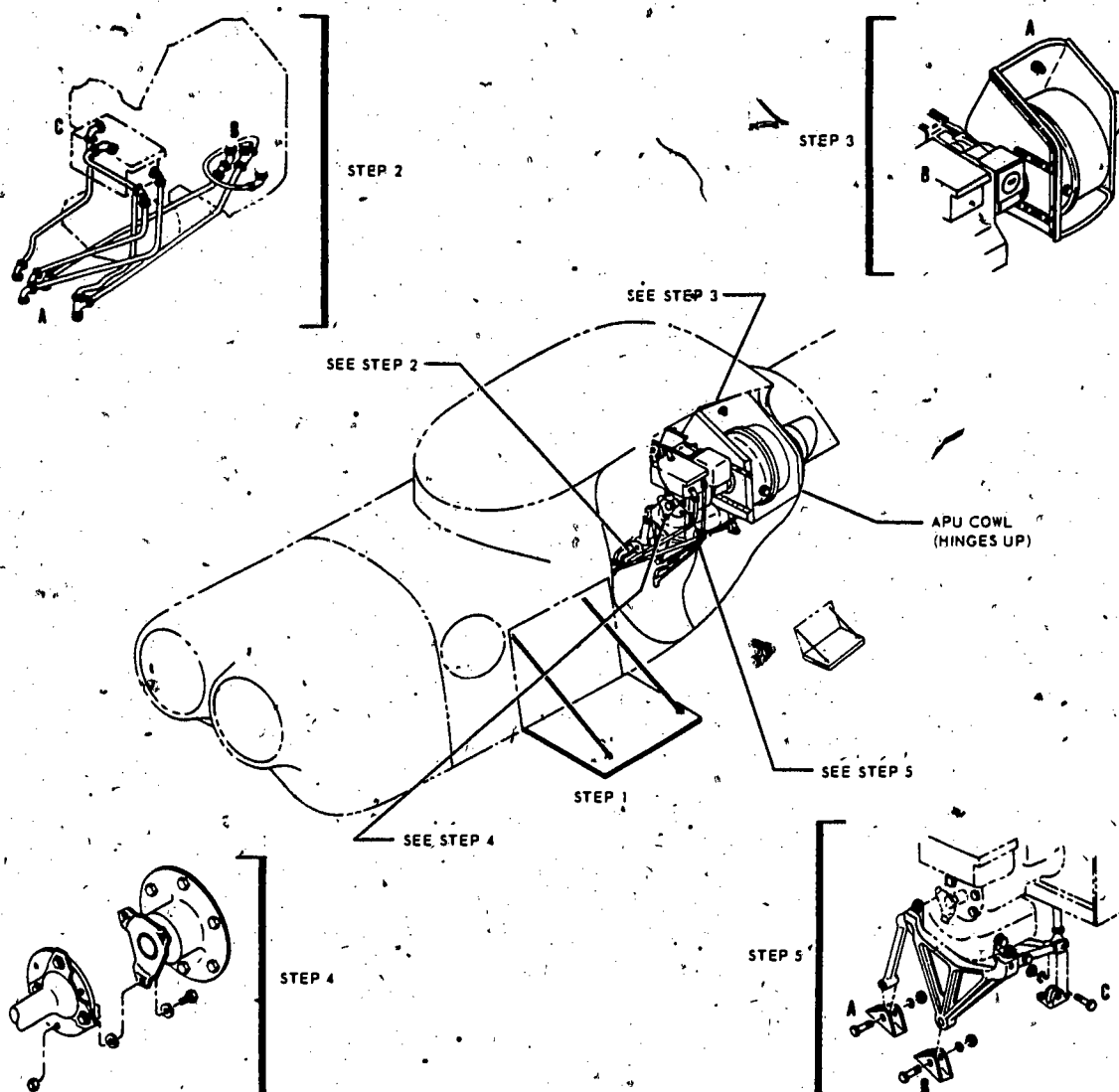


Figure 64. - Auxiliary power unit.

TURBINE ENGINE OPERATION

Air drawn through the intake by the impeller is centrifugally compressed and passed through the diffuser into the combustor, where the air is mixed with fuel from the fuel injectors. The resulting fuel-air mixture is ignited and burned. Expanding gases are directed out through the turbine nozzle, to the turbine wheel, and then vented through the exhaust into the atmosphere. The rotating turbine wheel, in turn, drives the compressor impeller and output shaft. During the starting cycle after the fuel pressure switch opens (110 ± 5 psi),

fuel from the start fuel nozzle and the main fuel injectors is ignited by the spark plug. At 90 percent speed, the start fuel nozzle and ignition are turned off by opening the speed switch. Combustion continues as long as fuel flows from the main fuel injectors.

Turbine

The turbine consists of a turbine housing, diffuser, turbine nozzle, and a combination impeller and turbine wheel. The turbine nozzle is cooled by air flow around the aft internal edge of the diffuser through holes in the turbine nozzle forward plate.

Combustor

The annular-type combustor (figure 65) consists of a housing, liner, and nozzle shield. The housing and liner form a passage through which compressed air from the impeller is directed into and around the combustion area for combustion and cooling. This compressed air also passes through deflector in the liner for cooling, and to center the flame. The nozzle shield protects the turbine nozzle from the effects of combustion and directs the flow of cooling air. Fuel is supplied through six equally spaced fuel injectors on the combustor housing. The compressed air mixes with the fuel and is ignited. If there is no ignition after fuel is sprayed into the liner, a drain for unburned fuel is provided on the lower center section of the housing. The expanding gases impinge on the turbine wheel and are then ducted to exhaust.

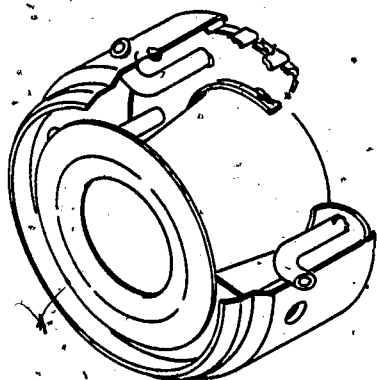


Figure 65. - Combustor.

Reduction Drive

The reduction drive is a system of gears which steps down the 56,700 rpm turbine speed to speeds required by the accessories. The reduction drive turns the APU drive shaft at 8,000 rpm and provides a 4,118 rpm output to the accessory section. The reduction drive also contains the turbine engine lubricating oil supply, oil pump, and oil filter.

Oil Filter

The oil filter, on the right side of the reduction drive, receives oil under

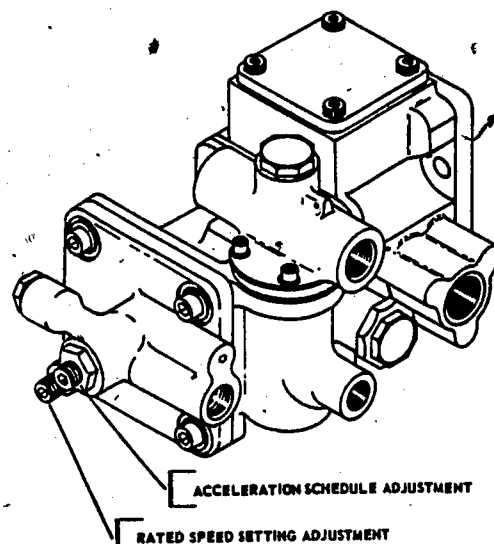


Figure 66. - Fuel control.

pressure from the oil pump and filters it prior to reaching the lubricating points. If the filter element clogs, a relief valve in the filter element cap unseats at 15 to 25 psi and bypasses the oil through a passage in the filter element cap, to the filter outlet passage.

Accessory Drive

The accessory drive is a two-piece four-pad magnesium housing containing an accessory drive gear, idler gear, and starter gear. The housing halves are bolted together and attached to the top of the reduction drive. Accessories are mounted on three pads of the housing. The fuel control and speed switch, mounted on opposite pads, are coupled to the accessory gear drive shaft. The tachometer-generator is mounted in tandem with the speed switch. The start motor is mounted on the remaining pad. The junction box is also mounted on the accessory drive.

Fuel Control

The fuel control (figure 66), on the accessory section of the turbine, consists of a fuel pump and a control assembly. The gear-type fuel pump supplies fuel pressure for engine operation and contains the fuel

filters. The control assembly has a rated speed adjustment and an acceleration adjustment, and consists of governor control components and valves. At full speed, the governor valve regulates fuel flow to maintain the turbine at nearly constant speed. If, upon application of a load, speed tends to drop, the flyweights increase fuel flow and thereby maintain constant speed. Similarly, increase in speed will be sensed by the flyweights, and the fuel flow will be reduced, thus decreasing engine speed. A minimum flow needle, installed in the fuel passage that bypasses the governor, allows a small amount of fuel under pressure to flow to the main fuel injectors even if fuel flow through the governor has been greatly reduced. Setting the minimum fuel flow needle maintains an adequate fuel flow to sustain combustion during momentary over control by governor control components.

Fuel Control Adjustments

The fuel control (figure 66) has a rated speed and an acceleration schedule adjustment. All fuel control adjustments should be made in small movements. No fuel control adjustments should be made until all other possible causes of malfunction have been investigated.

HYDRAULIC START SYSTEM

The APU hydraulic start system consists of a start valve, accumulator (figure 68) start motor, and hand pump. During starting of the turbine, the start valve is opened, allowing hydraulic pressure, built up by the air-charged accumulator, to act upon the start motor and crank the turbine. Hydraulic fluid for the start system is supplied by the utility hydraulic system fluid tank.

Start Motor

The start motor, mounted on the accessory section, is used to crank the turbine during starting. When the start valve is opened, hydraulic pressure from the accumulator passes through the valve to the start motor.

Accumulator

The accumulator (figure 68), mounted on the support brackets on the left side of the oil cooler, is air-charged and provides hydraulic pressure to start the turbine. The accumulator is initially charged with 1,600 psi air pressure. During operation of the utility hydraulic pump, the pressure is raised to 3,000 psi. When the start valve is opened, the pressure is released to start the turbine. As soon as the turbine reaches operating speed and is driving the main gear box accessory section, the utility pump pressure recharges the accumulator with 3,000 psi pressure.

Start Valve

The start valve, on the left side of the transmission deck outboard of the forward end of the accumulator, allows hydraulic pressure to reach the start motor when the valve is open.

Hand Pump

The pump (figure 67.) consists of a manual hydraulic pump, a pump handle, and a pressure gage on the pump. The pump is inside the cabin on the right structure, forward of the aft cabin window, at window sill level. The pump handle is clamped in a vertical stowed position above the pump. The wing nut on each clamp that secures the handle should always be wired. The pump is used to charge the accumulator, whenever the accumulator charge is insufficient to start the turbine. At -54° C. (-65° F.) a pressure of approximately 2,000 psi is required to start the turbine. A visual indication of pressure can be observed on the hand pump gage during pumping operations.

Ignition Exciter

The capacitor discharge-type exciter, secured to a bracket on the turbine housing, converts the direct current input to a high energy alternating current supplied to the spark plug for ignition. The output lead and terminal are integral parts of the ignition exciter.

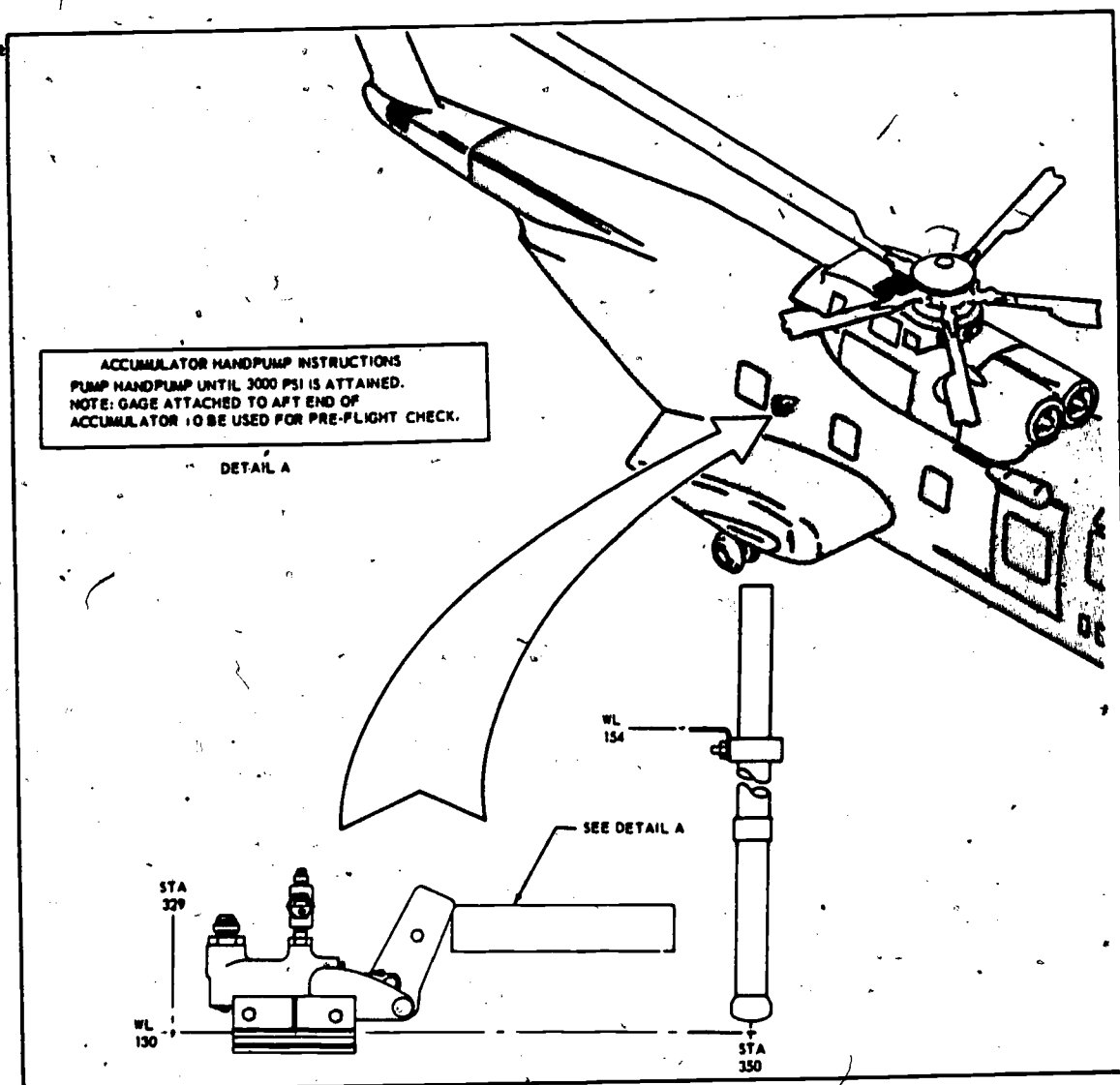


Figure 67. - APU accumulator hand pump.

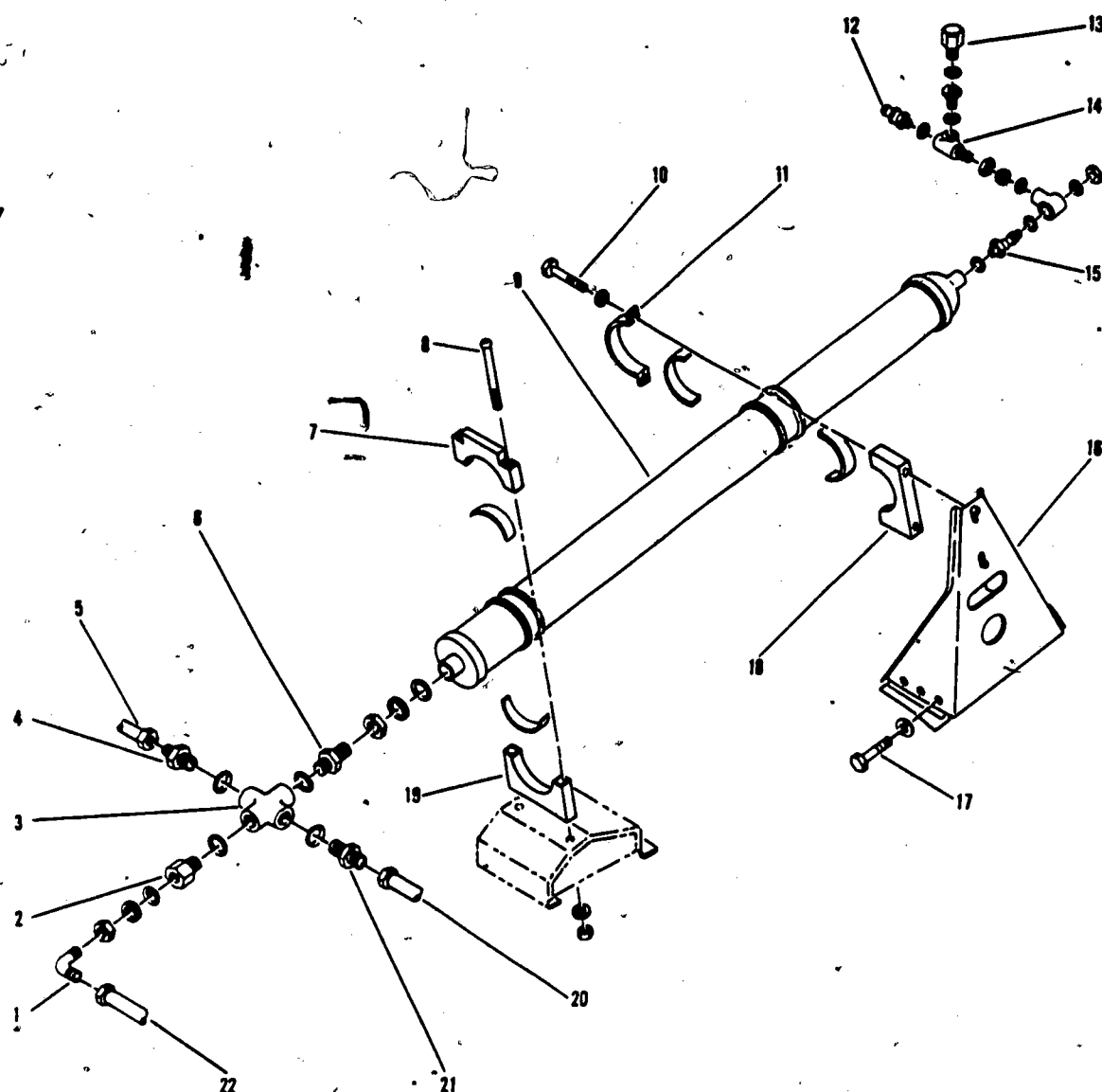
FUEL SYSTEM

The APU fuel system is independent of the helicopter fuel system, except that it receives fuel through a connection in the aft main fuel tank main line. The fuel valve, on the left side of the cabin above the floor forward of the aft fuel tank, controls flow of fuel to the turbine. The fuel shutoff valve is electrically actuated by the master switch on the APU CONTROL panel. With the master switch at START or RUN, electrical power from the DC PRI bus opens the fuel valve. The prime pump pumps fuel to the turbine only during the starting

procedure. A 20-second time delay is used which permits operation of the pump for 20 seconds. If the turbine does not start, the starting procedure must be repeated. The PRI-PUMP PRESS warning light, on the APU CONTROL panel, provides visual indication if prime fuel pressure is less than 2 psi.

DRIVE SHAFT

The drive shaft extends from the clutch to the flange on the adapter. The drive shaft transmits turbine power to drive the



- 1 Elbow, Nut, Ring, Packing
- 2 Bushing, Packing
- 3 Cross
- 4 Check Valve, Packing
- 5 Tube
- 6 Union, Nut, Ring, Packings
- 7 Clamp Half, Pad
- 8 Screw, Washer, Nut

- 9 Accumulator
- 10 Bolt, Spacer
- 11 Strap, Pad
- 12 Air Valve, Packing
- 13 Gage, Bushing, Packings
- 14 Fitting, Nut, Ring, Packing
- 15 Bolt, Body, Packings, Nut

- 16 Support
- 17 Bolt, Washer
- 18 Clamp Half, Pad
- 19 Clamp Half, Pad
- 20 Tube
- 21 Union, Packing
- 22 Tube

Figure 68. - Accumulator.

main gear box accessory drive section. Flexible steel couplings are on each end of the drive shaft.

CLUTCH

The clutch between the forward end of the drive shaft and the accessory drive

section of the main gear box, transmits power from the turbine to drive the gear box accessories. The clutch engages automatically when the turbine reaches 76 to 80 percent speed. The centrifugal force of the clutch driving part mechanism causes the brake shoe to engage with the clutch-driven surface. An integral free-wheeling unit allows the main transmission accessory

section to be rotated at a higher speed than the APU, thus unloading the APU. This occurs when the main transmission is being rotated by the main engines. The clutch is lubricated by the oil supply of the main gear box.

EXHAUST SYSTEM

The system consists of a shroud, exhaust stack, and exhaust temperature sensing system. The shroud and exhaust deflect heat away from the fuselage. The exhaust temperature sensing system provides protective circuitry for the APU system when the exhaust temperature exceeds its normal limits.

Shroud And Exhaust Stack

The shroud and exhaust stack deflect exhaust heat away from the fuselage. The shroud includes a front fire wall, front fire wall panel, rear fire wall, and exhaust shroud. The exhaust stack is mounted on the rear of the combustor.

APU EXHAUST TEMPERATURE SENSING SYSTEM

The APU exhaust temperature sensing system provides protective circuitry for the APU system when exhaust temperature exceeds 577° C. (1070° F.). The system consists of a turbine exhaust thermal switch mounted on the aft end of the combustor. When the temperature exceeds maximum limit, the normally closed contacts open, initiating control circuitry which closes the main fuel solenoid valve eliminating fuel flow to the engine.

Thermal Switch

The thermal switch is mounted on the combustor aft end with the sensing element projecting into the turbine exhaust. When exhaust temperature exceeds maximum limit, the normally closed contacts open, initiating control circuitry which closes the main fuel solenoid valve thereby causing engine shutdown.

Control Panel

The APU CONTROL panel (figure 69) on the pilot console contains all the controls

necessary to operate the APU. It consists of a master switch, warning lights, emergency controls, tachometer, and seven relays.

APU Warning Lights

(See figure 69.) The PRI-PUMP PRESS, LOW OIL PRESS, HIGH EXH TEMP, and OVER-SPEED warning lights are on the APU CONTROL panel. The PRI-PUMP PRESS warning light functions only during the first 20 seconds of the starting sequence and provides a visual indication of prime pump operation. The LOW OIL PRESS warning light functions only after the APU turbine engine has reached 90% speed. After a start has been made and the unit is up to operating speed, if oil pressure is lost, the low oil pressure switch opens. When the low oil pressure switch opens, the main fuel valve is closed, causing the APU turbine engine to shut down and the LOW OIL PRESS warning light to illuminate. If a high exhaust temperature occurs, relay K4 in the APU CONTROL panel de-energizes, closing the main fuel valve and illuminating the HIGH EXH TEMP warning light. If an overspeed condition occurs, relay K5 in the APU CONTROL panel de-energizes, closing the main fuel valve and illuminating the OVER-SPEED warning light. (See table 3.)

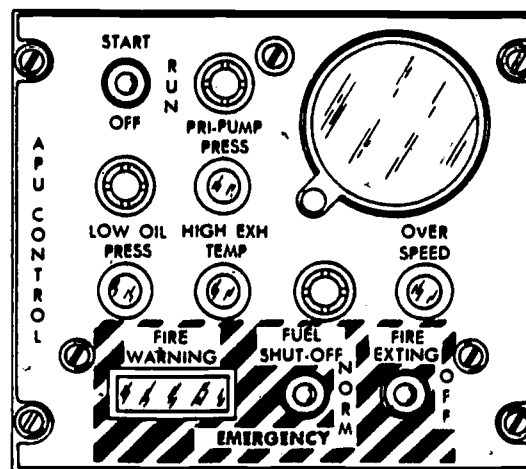


Figure 69. - APU control panel.

AUXILIARY POWER UNIT FIRE DETECTION SYSTEM

The auxiliary power unit fire detection system consists of five temperature sensing probes and FIRE WARNING capsules on the

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APU CONTROL panel, and caution advisory panel. The NO. 1 ENG/NO. 2 ENG & APU test switch, on the FIRE WARN TEST panel, is also used in this system. The temperature sensing probes contain normally open thermal switches which close at 232.2° C. (450° F.). One temperature sensing probe is installed in the fuel control can, and four are installed around the combustion chamber of the APU. If one of the probes senses a fire or overheat condition, the switch contacts close, providing a path to ground for the FIRE WARNING capsules, which will illuminate. The temperature sensing probes are wired together, and the path to ground is through the probe housing, so that the probes are in parallel, electrically. The test switch provides a path to ground for the FIRE WARNING capsules through the APU fire detection test relay, when held in the test NO. 2 ENG & APU position, and tests the operation of the light circuit. The FIRE WARNING capsules are press-to-test capsules and contain two lamps wired in parallel to provide protection against lamp failure. (See figure 69.)

NOTE

Helicopter modification T.O. 1H-3(H)F-563 added the capsule marked APU FIRE on the caution advisory panel.

AUXILIARY POWER UNIT FIRE EXTINGUISHING SYSTEM

The auxiliary power unit (APU) fire extinguishing system (figure 70) consists of a charged container, discharge nozzles, an overboard discharge tube, and a thermal discharge indicator. The container, in the aft main rotor fairing structure, is charged with CF₃Br plus a nitrogen charge to propel the extinguishing agent into the APU compartment. The forward discharge tube discharges into the APU fuel inlet pan. The rear discharge tube discharges into the combustion section of the APU. A safety outlet in the container is connected to the red thermal discharge indicator. If container temperature becomes excessive, the safety outlet opens, thermal discharge indicator seal is ejected, and the extinguishing agent is discharged overboard.

ENGINE FIRE DETECTION SYSTEM

The fire detection systems consist of engine fire warning lights, control units, sensing loops, and a test panel on the instrument panel. The systems provide a warning in the event of fire or excessive temperature rise in either of the engine

compartments. The control units monitor the impedance of the sensing loops which are run through potential fire zones of both engine compartments. Any large drop in sensing loop impedance, such as that caused by fire or an overheat condition, will activate the magnetic amplifier in the control unit and increase current flow in the power winding of the amplifier. This will cause illumination of either the NO. 1 ENGINE or the NO. 2 ENGINE FIRE EMER SHUT OFF SELECTOR handle, depending upon location of the fire; and the pilot's and copilot's FIRE warning lights on the instrument panel glare shield will illuminate. As the temperature in the fire zone drops below the warning point, sensing loop impedance increases, restoring the system to its original condition with all warning lights out.

EQUIPMENT COMPONENTS

Fire Warning Test Panel

The FIRE WARN TEST panel on the pilot's side of the instrument panel consists of a NO. 1 ENG/NO. 2 ENG, APU switch and an identification panel. The switch is used to test the No. 1 engine or No. 2 engine and APU fire detection components. The components consist of the pilot's and copilot's fire warning lights on the glare shield, the NO. 1 ENGINE and NO. 2 ENGINE FIRE EMER SHUT OFF SELECTOR handle lights on the overhead control panel, the control units, and associated wiring.

Fire Warning Lights

Two FIRE warning lights, pilot's and copilot's, mounted on the instrument panel glare shield, illuminate when a fire or an overheat condition exists in No. 1 engine compartment or No. 2 engine compartment.

Sensing Loops

Six temperature-sensitive FIRE DETECTION ELEMENT sensing loops, three for each engine warning circuit, are used in the fire detection system. A sensing loop consists of a sensing element, mounting connectors, interconnecting wires, and mounting clips. The

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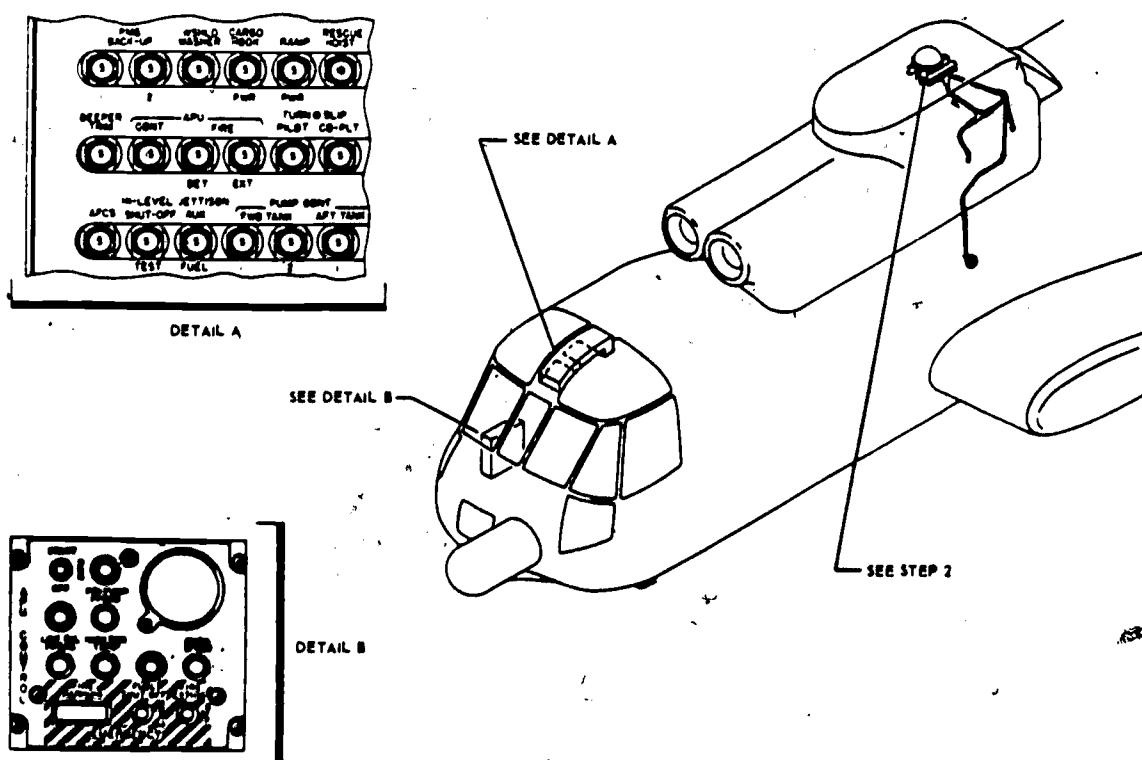


Figure 70. - APU fire extinguishing system.

hermetically sealed, flexible temperature-sensing element consists of a center conductor and an outer sheath with two end fittings. The space between the center conductor and the sheath contains a salt which lowers its impedance when exposed to fire or an overheat condition. Upon removal of the heat source, the system will reset automatically. The loops are secured to the sides of the engine compartments and service platforms.

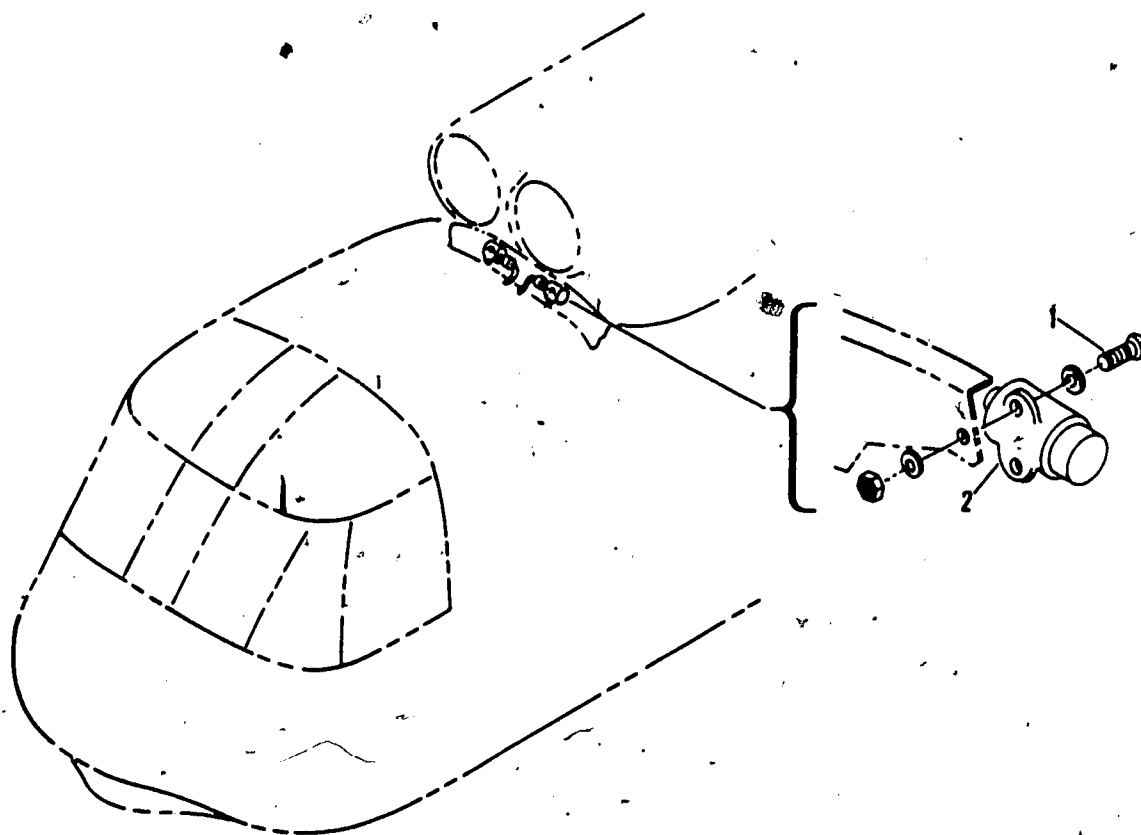
Control Unit

Two fire detection control units (figure 71), No. 1 and No. 2 ENG FIRE DET CONT UNIT, are installed on the cabin ceiling aft of the firewall valves. The control units are impedance sensing devices designed to monitor impedance changes in the sensing elements. Each control unit consists of a magnetic amplifier and test relay mounted in a hermetically sealed case. When the system

is in the standby condition, the magnetic amplifier is balanced. In case of fire or overheat condition, sensing element impedance is sharply lowered. As a result, input impedance to the control unit is lowered, activating the magnetic amplifier. At a critical system impedance, increased current in the power winding circuit of the amplifier will cause illumination of the FIRE warning lights on the instrument panel glare shield and the lights in the FIRE EMER SHUT OFF SELECTOR handles on the overhead control panel.

Interconnecting Cable

The four fireproof interconnecting cables have no heat sensing function and consist of end fittings and protective insulation. The cables connect the sensing elements attached to the engine compartments and engine service platforms to the control units to complete the sensing loop.



1 Bolt, Washers, Nuts

2 Fire Detection Control Unit

Figure 71. - Control unit.

TABLE 3. APU START/RUN

APU START/RUN CHECKLIST

MINIMUM CREW TO RUN APU - 1 FIREGUARD
1 COCKPIT OPERATOR

PREFLIGHT

1. SIGHT CHECK APU COMP., INTAKE & EXHAUST
2. APU WORK PLATFORM - closed
3. APU ACCESS DOORS - closed

MINIMUM CREW TO COMPLETE CHECKLIST - TWO
FIREGUARD MAY READ ALL ITEMS UP
TO #33, THEN ASSUME FIREGUARD
POSITION

STARTING CHECKLIST (#1-3 FOR NIGHT ONLY)

1. BATTERY SWITCH - on

2. COCKPIT LIGHTING CONTROL - 7 rheostat full
3. PILOTS OVERHEAD MAP LIGHT - on & positioned

NORMAL DAYTIME PROCEDURES

4. OVERHEAD CIRCUIT BREAKERS - set
5. ENG ANTI-ICE - off
6. WINDSHIELD ANTI-ICE - off
7. SEARCH LIGHT - off
8. ANCHOR LIGHT - off
9. FUSELAGE LIGHT - off
10. ANTI-COLLISION LIGHTS - off (2)
11. POSITION LIGHTS - off
12. CABIN HEATER - normal & off
13. PITOT HEAT - off
14. WINDSHIELD WIPERS - off
15. WINDSHIELD WASHERS - off
16. LOADING LIGHTS - off

17. EMERG LIGHT - arm
18. NOSE GEAR - normal
19. HOIST MASTER - off
20. CARGO HOOK - off
21. STICK TRIM MASTER - on
22. CHANNEL MONITOR - off
23. CONVERTERS (2) - on
24. EXT PWR - off
25. BATTERY - on
26. GENERATOR SWITCHES (2) - on
27. ROTOR BRAKE - on press min 320 psi
28. GEAR HANDLE - down/green lights
29. PARKING BRAKE - set
30. RAMP MASTER - off
31. APU FUEL SHUT OFF - normal
32. APU FIRE EXTINGUISHER - off
33. APU START/RUN SWITCH - run
CK FOLLOWING LIGHTS ON - high exch temp
& overspeed

PRESS TO TEST - prime pump press/low oil.
press ENG FIRE WARNING TEST SWITCH TO #2
ENG/APU FIRE LIGHT ONLY

34. FIREGUARD - in position
35. APU START/RUN SWITCH - start position
until Ng passes
45%, then re-
lease to run
36. APU CLUTCH ENGAGEMENT - 76 to 80% Ng
37. HYDRAULIC PRESS GAGES (3) - press up
38. WARNING PANEL LIGHTS - tested
following lights must be out - on warn-
ing panel CONVS 1 - 2, GENS 1-2, PRI-
HYD PRESS AUX-HYD PRESS XMISSN OIL
PRESS & XMISSN CHIP DET
39. BATTERY - off

SECURE CHECK LIST

1. BATTERY - on
2. EMERG LIGHT - disarm
3. APU START/RUN SWITCH - off
4. COCKPIT LIGHTING CONTROL - 7 rheostat
closed
5. STICK TRIM MASTER - off
6. CONVERTERS (2) - off
7. GENERATORS (2) - off
8. PILOTS OVERHEAD MAP LIGHT - off
9. COCKPIT DOME LIGHT - off
10. BATTERY SWITCH - off

APU FIRE FIGHTING PROCEDURES - (obtain posi- tive indication of fire before firing EXTING)

1. APU EMERG FUEL SHUT OFF - shut-off
2. APU FIRE EXTING - fire exting
3. APU MASTER SWITCH - off
4. EXIT A/C ASSIST FIGHTING FIRE

APU LIMITATIONS

1. CLUTCH ENGAGEMENT - 4 - 6 seconds
2. Ng TOPPING - 99% * plus-or minus 1%
3. MOMENTARY OVERSHOOT - 110% Ng
4. TOTAL TIME FOR START - approx 10 sec
(never exceed 8 sec)
5. ABORT START IF -
 - a. No Ng indication
 - b. Warning light on APU panel lit
 - c. Warning lights cited in #38 lit
 - d. APU limitation exceeded
6. APU ADVISORY LIGHT ON WARNING PANEL on
above 30% Ng

REVIEW

In this section we have discussed the auxiliary power unit, APU and engine fire detection systems, and APU fire extinguishing system. We have also covered the APU start/run procedures.

(Now complete the following review questions.)

53. Fuel to operate the APU is taken from the _____ fuel tank. 53.-C (Refer to page 103)
- A. forward main
 - B. forward aux
 - C. aft main
 - D. aft aux
54. The APU start fuel valve is energized until the unit reaches _____ percent of its rated speed. 54.-C (Refer to page 103)
- A. 50
 - B. 75
 - C. 90
 - D. 100
55. Holes are provided in the APU turbine nozzle forward plate to _____. 55.-D (Refer to page 104)
- A. lighten the turbine nozzle
 - B. direct airflow to the 2nd-stage nozzle
 - C. cool the turbine wheel
 - D. cool the turbine nozzle
56. APU speed changes are sensed in the fuel control by _____. 56.-A (Refer to page 106)
- A. flyweights
 - B. a bellows
 - C. a minimum flow needle
 - D. an acceleration limiter valve
57. The APU is started by a/an _____. 57.-D (Refer to page 106)
- A. electric motor
 - B. air turbine starter
 - C. electric starter
 - D. hydraulic motor
58. The APU clutch is engaged by _____. 58.-B (Refer to page 108)
- A. a solenoid
 - B. centrifugal force
 - C. a fixed connection
 - D. oil pressure

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59. The purpose of the thermal discharge indicator in the fire extinguisher system is to indicate _____.

- A. that the container has discharged due to an abnormally high container pressure
- B. that the container chemical has become overage
- C. that the container pressure has dropped too low to be effective
- D. the temperature of the chemicals within the container

60. The two engine fire detection control units operate by detecting changes in electrical _____ in the fire sensing elements.

- A. inductance
- B. resistance
- C. impedance
- D. reactance

61. The APU START/RUN switch is held in the start position until Ng passes _____ on the start cycle.

- A. 38%
- B. 45%
- C. 76%
- D. 80%

59.-A This gives the aircrew a visual indication of a discharged container. (Refer to page 110)

60.-C (Refer to page 110)

61.-B (Refer to page 113)

HEATING, VENTILATING, AND ANTI-ICING SYSTEMS

OBJECTIVES

When you complete this section, you will be able to:

1. Summarize the operation of the HH-3F heater system.
2. Identify the heater system components and explain their function.
3. Describe the windshield anti-icing system.
4. Summarize the engine anti-icing system.

HEATING SYSTEM

The heating system (figures 72 and 73) consists of a 200,000 BTU heater and its fuel, air, ignition, and distribution systems, and the necessary electrical control circuits. The fuel system supplies fuel for combustion, and the air system supplies air for combustion and ventilating. The ignition system supplies a continuous spark for ignition of the fuel-air mixture. The distribution system distributes heated ventilating air throughout the cockpit and cabin and also permits heat flow regulation at any given location within the helicopter. Ventilating with the heating system is done by operation of the blower only. With the CABIN HEATER LOW, OFF, HIGH switch in the OFF position and the CABIN HEATER NORM, VENT blower switch in the VENT position, the blower will force outside air through the otherwise inoperative heating system and into the helicopter. A conversion kit is available to convert the heating system into a ventilating system for warm weather operations. The kit consists of an adapter which replaces the heater and forward adapter, covers to close the heater exhaust opening and the thermal switch openings, and associated hardware.

ELECTRICAL OPERATION

With the CABIN HEAT VENT and CONT and the CABIN HEATER BLOWER circuit breakers engaged and the CABIN HEATER LOW, OFF, HIGH switch in the HIGH or LOW position, power from the fan overrun relay energizes the blower relay and the blower starts. When sufficient air is being delivered, the air

pressure switch closes. Power then flows through the time delay relay to energize the overheat relay. When the overheat relay is energized, power is supplied through the relay to operate the fuel pump, master fuel valve, and ignition unit. A circuit through the CABIN HEATER LOW, OFF, HIGH switch operates the heater control unit cycling valve through either of the normally closed 65.6° C. (150° F.), or 140.6° C. (285° F.) thermal switches, depending on whether the CABIN HEATER LOW, OFF, HIGH switch is in the HIGH or LOW position.

With the air-fuel mixture and ignition spark being supplied, the heater operates, supplying heated ventilating air for the cabin and cockpit and discharging exhaust gases overboard. The heater continues to operate until the proper normally closed thermal switch opens and de-energizes the control unit cycling valve to shut off fuel supply and ignition power to the heater. The blower still operates and as the plenum and crossover duct temperature drops, the proper thermal switch closes, to continue heater operation to maintain the desired temperature.

If air in the plenum chamber approaches unsafe temperatures, the normally closed 176.7° C. (350° F.) thermal switch opens and de-energizes the overheat relay. The overheat relay opens the heating system circuit to stop fuel flow and ignition to the heater, while the blower continues to operate to bring the plenum temperature down to safe limits. If exhaust temperature fails to reach 93.3° C. (200° F.) within 45 seconds, heater operation is also interrupted by the ignition sensing control relay circuit. Under these circumstances, or when the CABIN HEATER LOW, OFF, HIGH switch is

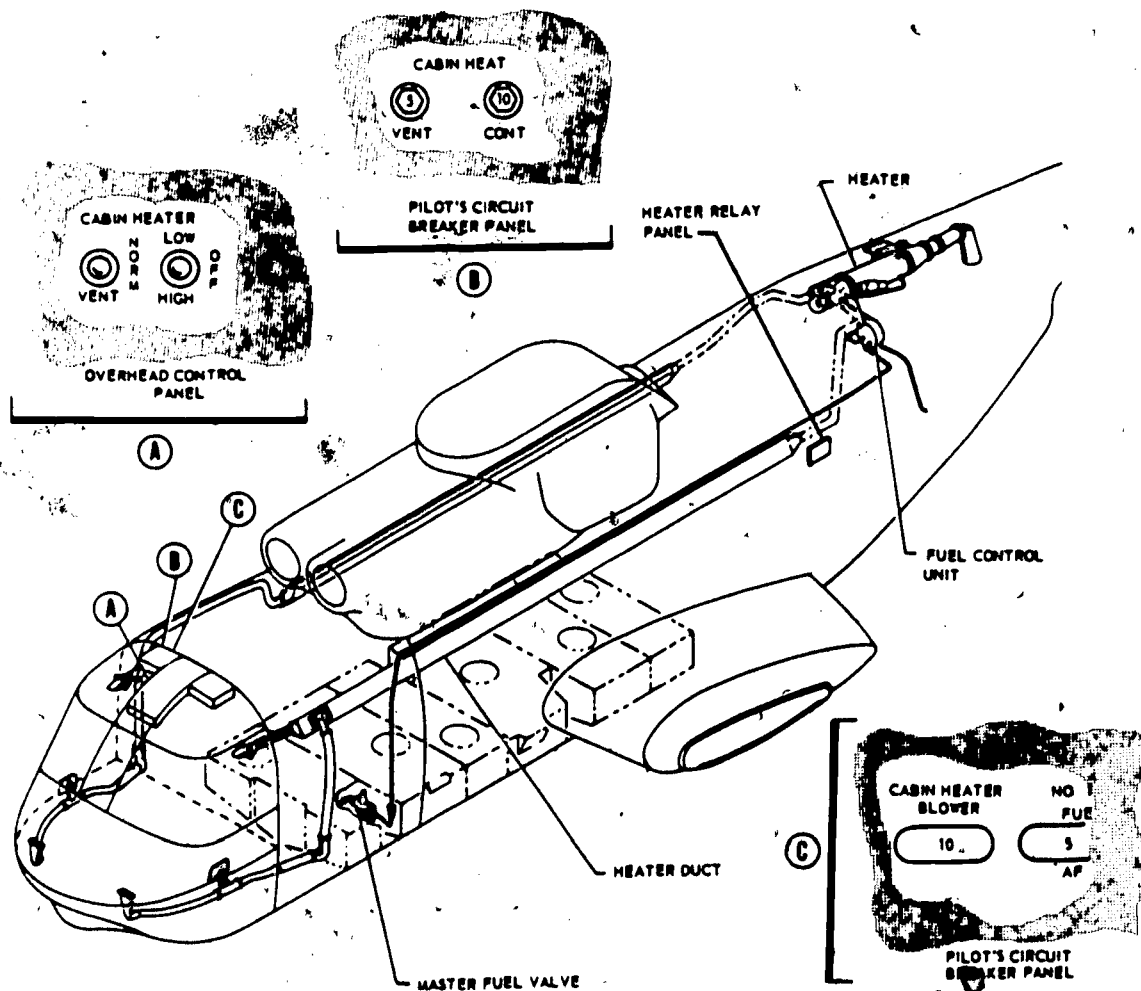


Figure 72. - Heating system - component location diagram.

in the OFF position, all power to the system is removed except for the circuit through the normally open 48.9° C. (120° F.) thermal switch. This circuit bypasses the CABIN HEATER LOW, OFF, HIGH switch to continue blower operation until plenum duct temperature is below 48.9° C. (120° F.) to provide safe cooling of the heater and proper exhaust of combustion gases.

EQUIPMENT COMPONENTS

Heater Controls

Heater controls (figures 72 and 73) consist of two switches: the CABIN HEATER LOW, OFF, HIGH switch, and the CABIN HEATER

NORM, VENT blower switch on the overhead control panel. The CABIN HEATER LOW, OFF, HIGH switch controls the system for HIGH or LOW heater operation, and the CABIN HEATER NORM, VENT blower switch allows blower operation when ventilation only is desired.

Heating System Relays

Five relays, the fan overrun relay, blower relay, overheat relay, ignition sensing relay, and ignition control time delay relay, control the heater electrical system. The relays are on the heater relay panel in the aft fuselage. The fan overrun relay is energized when the CABIN HEATER LOW, OFF, HIGH switch has been placed in the HIGH or LOW position. The fan overrun relay controls the blower relay. The blower relay

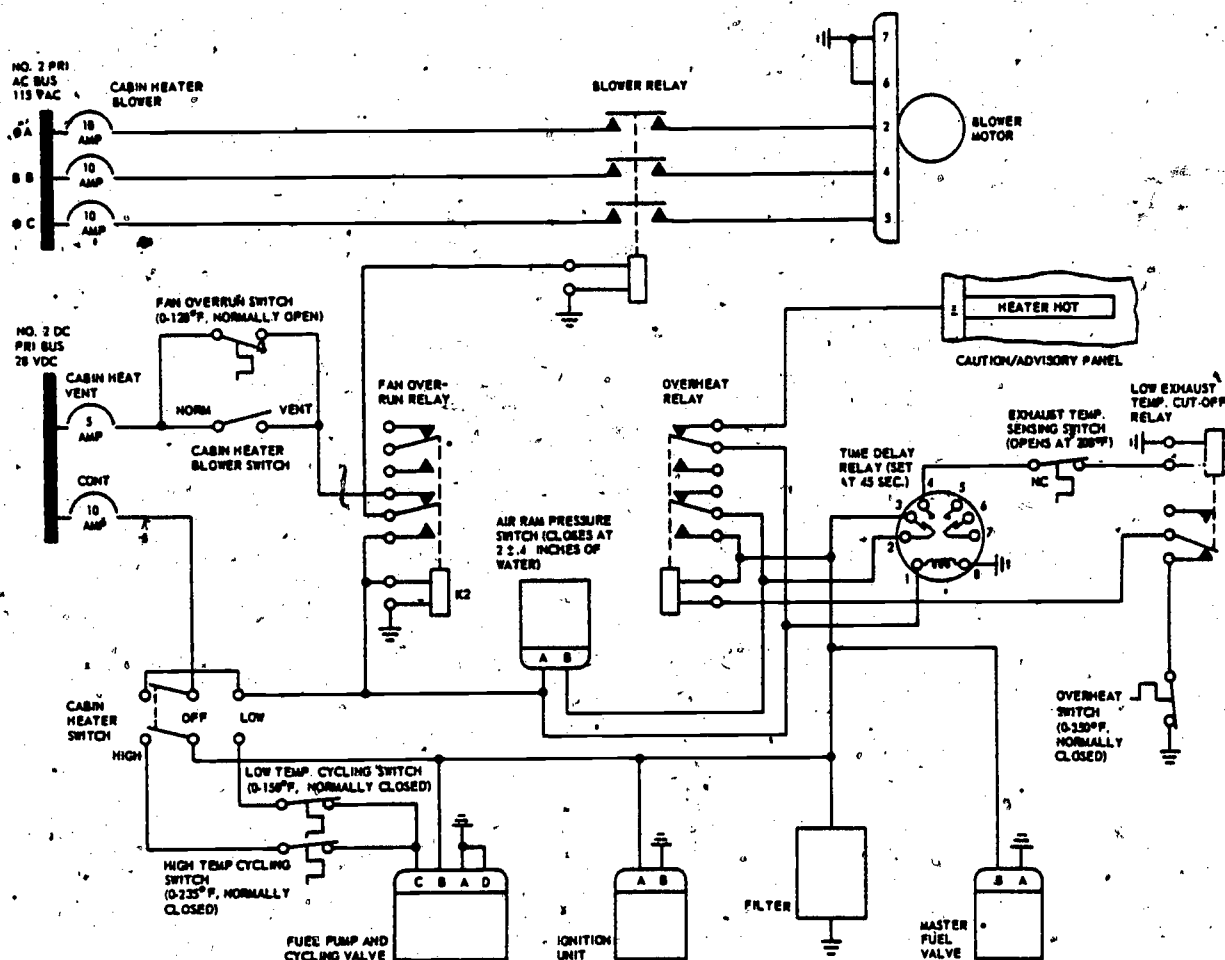


Figure 73. - Heating system - schematic diagram.

is energized by the fan overrun relay and through contacts in the fan overrun relay when the CABIN HEATER NORM, VENT blower switch is in the VENT position, or by operation of the 48.9° C. (120° F.) thermal switch. The blower relay controls power to the blower motor. The overheat relay is energized when the CABIN HEATER LOW, OFF, HIGH switch is in the LOW or HIGH position through the ram air pressure switch and the ignition control time delay relay. The overheat relay controls the HEATER HOT caution light, master fuel valve, fuel pump, and ignition unit. The overheat relay is de-energized by the ignition sensing control relay through the ignition control time delay relay, or by the overheat switch. The ignition sensing control relay is energized through the 93.3° C. (200° F.) thermal switch when the ignition control time delay relay is energized (45 seconds after the

heater is turned on) and the exhaust temperature has not reached 93.3° C. (200° F.). When energized, the ignition sensing control relay de-energizes the overheat relay to interrupt the operation of the heater. The ignition control time delay relay is energized 45 seconds after the CABIN HEATER LOW, OFF, HIGH switch has been positioned to HIGH or LOW.

Heater

The 200,000 BTU heater (figures 72 and 74) is a spark-spray type combustion heater in the aft fuselage compartment. It is capable of obtaining a temperature rise to 4.44° C. (40° F.) in the cockpit and cabin when the ambient air temperature is -53.9° C. (-65° F.). The heater consists

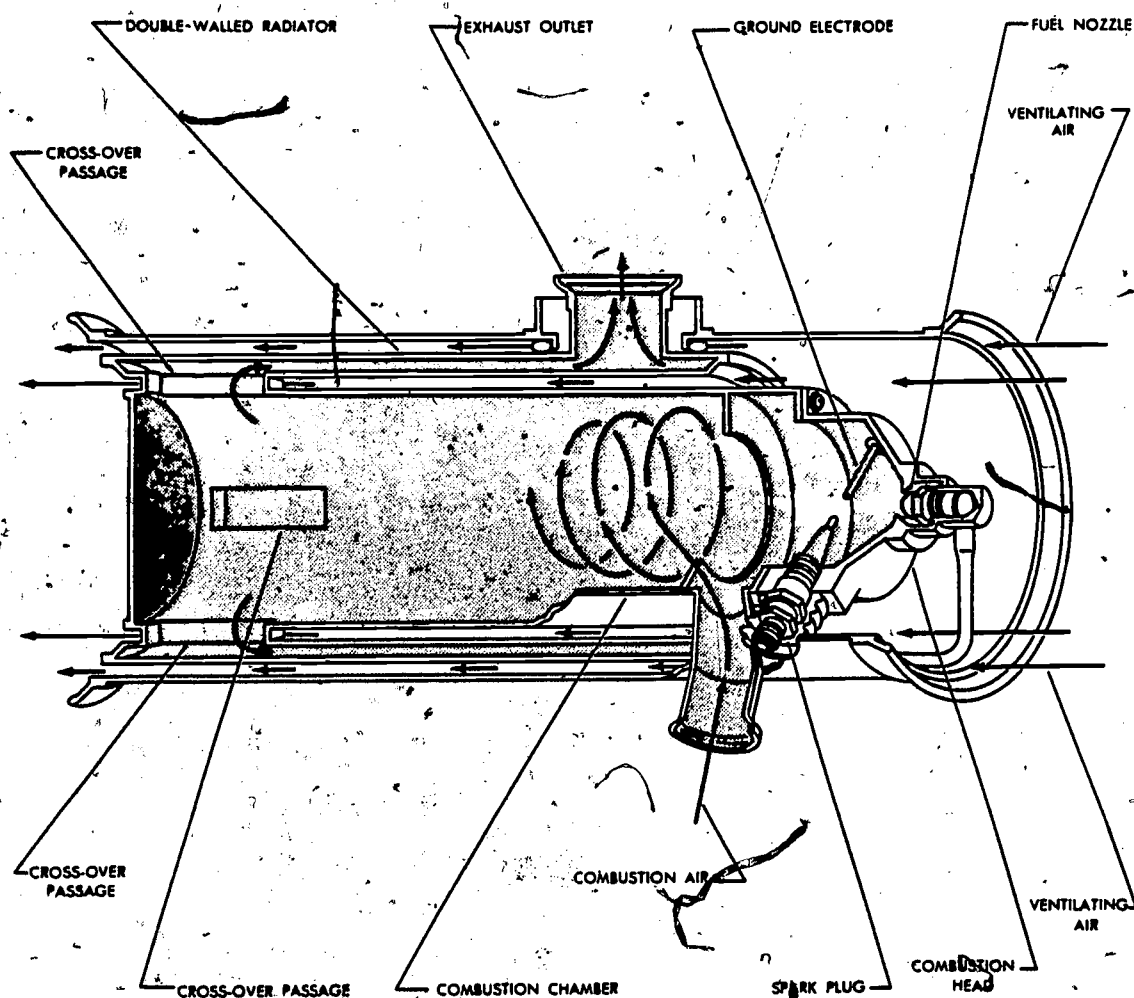


Figure 74. - Heater - schematic diagram.

of a heater jacket, combustion chamber, radiator, combustion head, fuel spray nozzle, spark plug, and ground electrode. The heater jacket, clamped at the back to the adapter assembly and at the front to the plenum chamber, encircles the radiator, which in turn encircles the combustion chamber. The area between the heater jacket, combustion chamber, and radiator is a pass for the flow of ventilating air. The combustion chamber is connected to the radiator by an internal crossover passage. Combustion gases from the combustion chamber flow through the crossover passage into the radiator. The radiator absorbs the heat and then exhausts the gases overboard. The combustion head, fitted over the back end of the combustion chamber, serves as a mounting for the fuel spray nozzle, spark plug, and ground electrode. Combustion air supplied by

the blower is ducted separately from the ventilating air and enters through a combustion air inlet on the side of the heater. Fuel passing through the nozzle, under pressure, is converted to a fine spray, mixed with combustion air, and ignited by the spark plug and ground electrode. An overboard drain line is connected to the bottom of the combustion chamber to prevent unburned fuel from collecting.

Heater ignition system

The ignition system consists of an ignition unit and a shielded ignition lead which supply power to the spark plug for ignition of the fuel-air mixture.

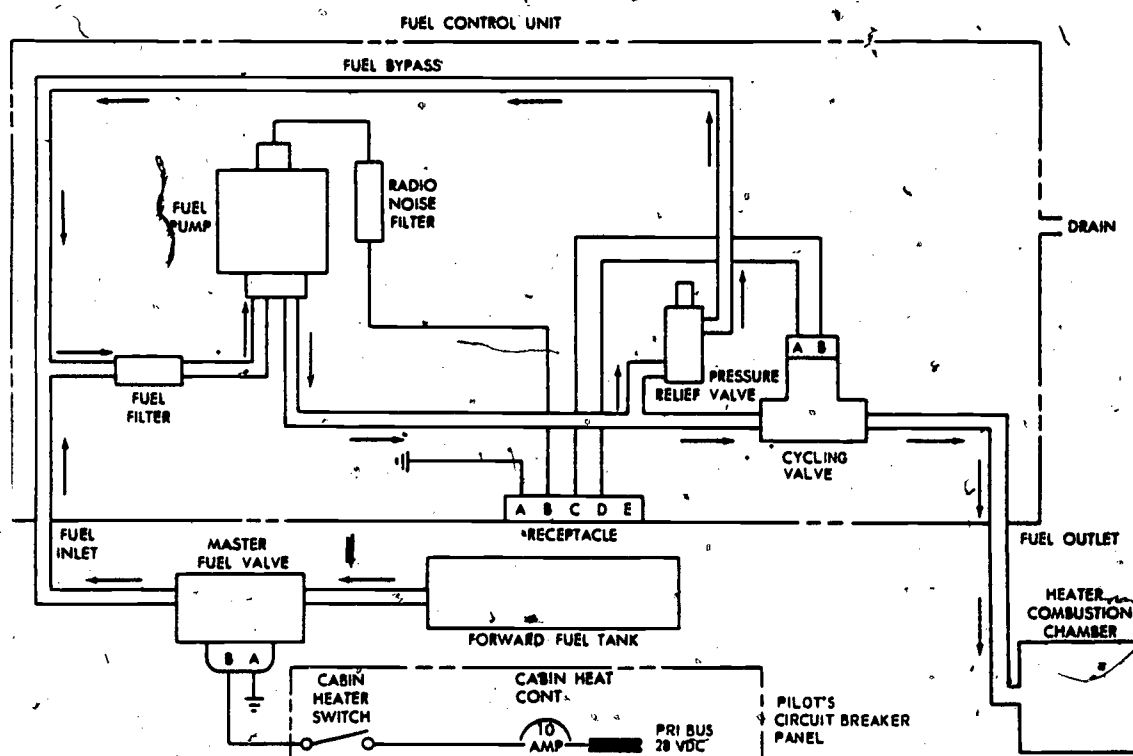


Figure 75. - Heater fuel control unit - schematic diagram.

Ignition Unit And Shielded Ignition Lead

The ignition unit, secured to the fuselage next to the heater, is connected to the spark plug by the shielded ignition lead. The ignition unit converts 28-volt DC current to a high-voltage oscillating current for continuous ignition in the heater. The ignition unit includes two radio noise filters, a condenser, a fuse, a relay, a vibrator with two sets of points and a NOR/RES point selector switch, and a junction box. Under all normal conditions, this switch is in the NOR position. If the points fail, the switch may be operated on the RES (reserve) points.

Heater Fuel System

The fuel system (figure 75) consists of a fuel control unit and a master fuel valve. The fuel control unit supplies fuel from the forward main fuel tank through the master fuel valve and also controls fuel flow in response to the thermal switches. In event of leakage within the

fuel control unit, provisions are made for draining the fuel overboard. The master fuel valve is electrically operated to stop fuel flow to the heater in event of overheating and when the heater is shut off. An overboard drain is also provided to prevent unburned fuel from accumulating in the combustion chamber.

Fuel Control Unit

The fuel control unit (figure 75) is a sealed container attached to the bulkhead in the aft fuselage compartment. The unit contains a fuel filter, fuel pump, pressure relief valve, and control unit cycling valve. The fuel filter removes impurities in the fuel. The fuel pump delivers fuel through the control unit cycling valve to the heater. The pressure relief valve relieves excessive pressure from the pump. The control unit cycling valve permits passage of fuel until either the 65.6° C. (150° F.) or 140.6° C. (285° F.) thermal switches open. Also, the cycling valve will close when the 48.9° C. (200° F.) thermal switch opens.

Air System

The air system (figures 72 and 73) consists of a blower, an air pressure switch, and a plenum chamber. The blower supplies both combustion and ventilating air to the heater. The air pressure switch controls heater operation if there is insufficient air for safe operation of the heater. The plenum chamber is an air distributing center to the ventilating air distribution ductwork and, with the crossover and heater exhaust tube, serves as a mounting for the thermal switches.

Blower

The blower is installed in the aft fuselage compartment between the combustion air inlet and the adapter. It forces air into the heating system when the CABIN HEATER LOW, OFF, HIGH switch is placed in either the HIGH or LOW position and the CABIN HEATER VENT, NORM blower switch is in the VENT or NORM position. The 48.9° C. (120° F.) thermal switch serves as an overrun switch which causes the blower to operate until the plenum duct temperature drops below 48.9° C. (120° F.) even though the CABIN HEATER LOW, OFF, HIGH switch has been set to OFF, and the CABIN HEATER VENT, NORM switch has been set to NORM.

Master Fuel Valve

The master fuel valve (figure 75) is installed in the heater fuel supply line on the bulkhead forward of the forward fuel tank. Access to the valve is gained by removing the access cover on the forward floor panel. It functions as a safety valve to stop the flow of fuel to the heater when the 176.7° C. (350° F.) overheat thermal switch, 48.9° C. (200° F.) overheat thermal switch, and overheat relay are actuated or when the heater is shut off.

Air Pressure Switch

The air pressure switch (figure 73), secured to a bracket next to the heater, is connected to the combustion air inlet

with tubing. The switch opens the electrical circuit to the heater if there is insufficient air for safe heater operation. The switch is normally open and is actuated by differential air pressure between the air surrounding it and the air pressure in the combustion air inlet. When the pressure differential reaches 2.0 ± 0.4 inches of water, the switch completes an electrical circuit permitting operation of the heater. Should the pressure differential drop more than 1.0 ± 0.4 inches of water, the point at which air supply would be insufficient for proper combustion within the heater, the air pressure switch opens the electrical circuit, shutting off the heater.

Plenum Chamber

The plenum chamber (figure 72), constructed of sheet metal, is between the heater and the distribution system. It serves as a mounting for thermal switches and as an air distributing center for the ventilating air distribution ductwork. Thermal switches, mounted on the plenum chamber, in the crossover duct, and in the heat exhaust tube, control operation of the heater.

Distribution System

Two heating ducts (figure 72) are connected to the plenum chamber and run forward along the cabin ceiling into the cockpit above the pilot's and copilot's heads and under the cockpit floor to registers and diffusers on both sides of the cockpit. Four circular adjustable valves in the cockpit and 12 adjustable diffusers in the cabin disperse and control the flow of warm air. The flow of warm air is regulated by turning the knob on the diffusers for volume control and pulling the center vane down for directional control. A terminal outlet or diffuser is installed at the end of each duct to pass air for ventilation and prevent overloading of the blower motor. These terminal outlets cannot be closed.

THERMAL SWITCHES

Five thermal switches (figure 73), three in the plenum chamber, one in the

crossover duct, and one on the exhaust tube, are installed for controlling operation of the heating system. The normally closed 93.3° C. (200° F.) ignition thermal switch in the exhaust tube de-energizes the overheat relay by actuating the ignition sensing control relay if exhaust temperature has not reached 93.3° C. (200° F.) within 45 seconds after the heater is turned on, or if combustion is lost due to any reason after 45 seconds. The 176.7° C. (350° F.) switch is an overheat thermal switch which is normally closed. Above 176.7° C. (350° F.), the switch de-energizes the overheat relay to remove power from all components of the heating system except for the blower. The normally open 48.9° C. (120° F.) thermal switch energizes the blower relay and causes the blower to operate whenever the temperature in the plenum chamber exceeds 48.9° C. (120° F.) and the DC essential bus of the electrical system is energized. The 140.6° C. (285° F.) thermal switch in the plenum chamber or the 65.6° C. (150° F.) thermal switch in the crossover duct regulates the heating system temperature depending upon whether the CABIN HEATER LOW, OFF, HIGH switch is in the HIGH or LOW position. The thermal switches are removed by disconnecting the electrical wiring and by removing the securing screws and washers.

ANTI-ICING SYSTEMS

Anti-icing systems (figures 76 and 78) consist of the windshield and engine anti-icing systems. The windshield anti-icing system is electrically operated by heating elements in the pilot's and copilot's windshield panels. When the WINDSHIELD ANTI-ICE control switch on the overhead switch panel is positioned to HIGH, the system protects the windshields against formation of ice; when the control switch is positioned to LOW, the system will defog the windshields. The engine anti-icing system consists of two subsystems, the engine air intake duct anti-icing system and the inlet guide vane anti-icing system. Both subsystems are actuated by No. 1 and No. 2 ENGINE ANTI-ICE switches on the overhead switch panel. The electrically operated engine air intake duct anti-icing system prevents formation of ice on the intake duct. The inlet guide vane anti-icing system uses engine bleed air to heat the guide vanes, front frame, and starter cover to prevent ice buildup.

WINDSHIELD ANTI-ICING SYSTEM

The windshield anti-icing system (figure 76) consists of a WINDSHIELD ANTI-ICE control switch, a windshield temperature controller, two step-up transformers, a resistor assembly, and two electrapane windshield panels. The WINDSHIELD ANTI-ICE control switch, on the overhead switch panel, has three positions: LOW, OFF, and HIGH. The LOW position is used for defogging operations, and the HIGH position is used to prevent ice formation on the windshield. The windshield temperature controller, on a shelf in the electronics compartment, controls operating current to the heating elements in the windshield panels. The step-up transformers in the electronics compartment increase output voltage from the controller to the heating elements. The electrapane windshield panels incorporate heating elements and a temperature sensor imbedded between plate glass laminations. The sensor senses temperature of the windshield and provides a signal for the controller to regulate the application of electrical power to the heating elements. Placing the control switch in the LOW or HIGH position places different resistors of the resistor assembly in series with the sensors that permit operation of the system at two different temperatures for defogging or anti-icing conditions.

Electrical Operation

The temperature sensor, imbedded in each electrapane windshield panel, is a resistor which changes value as the temperature of the windshield changes. A decrease in temperature causes a decrease in resistance; conversely, an increase in temperature causes an increase in resistance. Each temperature sensor is wired as part of the control leg of a sensitive resistance bridge network in the temperature controller. With the WINDSHIELD ANTI-ICE control switch in the LOW position, each sensor is in series with a 9.3-ohm resistor and a 22-ohm resistor (31.3-ohms total). With the control switch in the HIGH position, the 22.0-ohm resistor is dropped from the circuit, which allows the windshields to attain a higher temperature. When the sensitive relay is de-energized, an additional 3.7-ohm resistor is added to the control leg in series with the sensor.

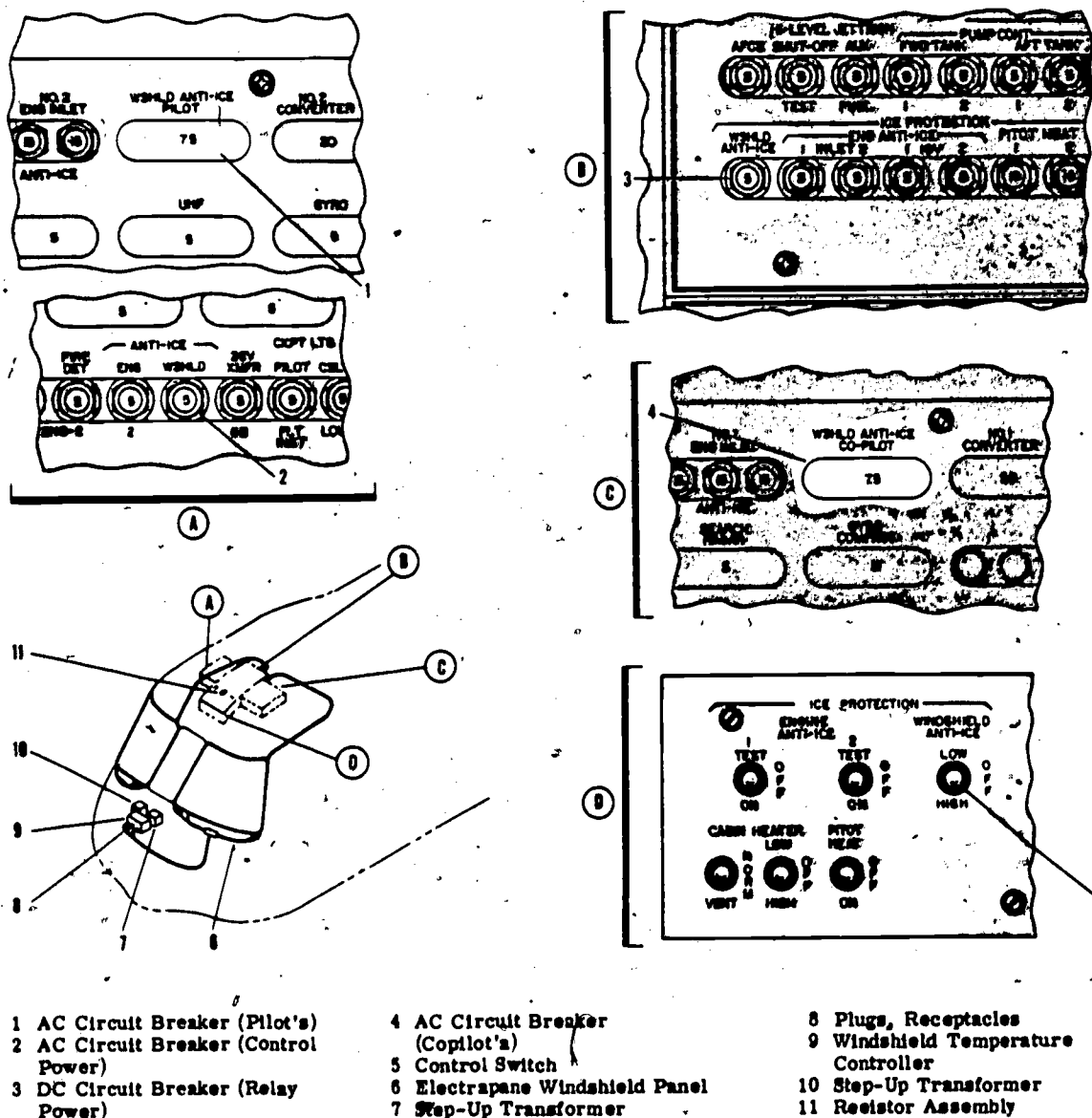


Figure 76. - Windshield anti-icing system.

Low Operation. - When the WINDSHIELD ANTI-ICE control switch is positioned to LOW for a fogged windshield condition, excitation voltage is provided for the sensitive resistance bridge network, and 35.0-ohms resistance (9.3-ohm resistor + 22.0-ohm resistor + 3.7-ohm resistor) is in series with the sensor. If the windshield ambient temperature is below approximately 25° C. (77° F.), the sensor resistance will be below 315.4 ohms, and the total resistance of the control leg will be below 350.4 ohms (315.4 + 35.0). For a balanced

bridge network, the control leg resistance should be 350.4 ohms. Because the control leg is below 350.4 ohms, the sensitive resistance bridge network is unbalanced, resulting in a differential voltage across the windings of the amplifier. Output of the amplifier is rectified voltage that energizes the sensitive relay. The 3.7-ohm resistor, part of the sensitive resistive bridge network, is shunted by the normally open contacts of the sensitive relay, thereby driving the bridge network further out of balance, and ensuring the positive

closure of the sensitive relay. Another set of normally open contacts of the sensitive relay provides a path for 28 volts DC to energize the coil of the power relay. With the power relay energized, three-phase 115-volt AC is coupled to the step-up transformer, where the voltage is increased by a factor of two. This stepped-up voltage is applied to the heating elements, located in the windshield panel. As the temperature of the windshield increases, the resistance of the temperature sensor increases until the bridge network is balanced. The bridge network will become balanced at a temperature of approximately 27.8° C. (82° F.), when the sensor resistance reaches 319.1 ohms; 319.1 ohms plus 9.3 ohms plus 22.0 ohms equals 350.4-ohms total resistance in the control leg. With no differential voltage applied to the amplifier, the sensitive relay de-energizes causing the power relay to also de-energize, removing the voltage previously applied to the heating elements of the windshield panel. With the sensitive relay de-energized, the 3.7-ohm resistor is added to the resistance of the control leg, which now totals 354.1 ohms. Now the sensitive relay cannot be energized until the control leg resistance is below 350.4 ohms, which, as previously described, will not occur until the windshield has cooled to below approximately 25° C. (77° F.). The temperature controller will attempt to maintain the windshield panels between approximately 25° and 27.8° C. (77° and 82° F.) to keep the pilot's and copilot's windshields clear. If ambient temperature is high, it may be necessary to place the WINDSHIELD ANTI-ICE control switch in the HIGH position. (See figure 77.)

High Operation. - When the WINDSHIELD ANTI-ICE control switch is positioned to HIGH for iced windshield conditions, excitation voltage is provided for the sensitive resistance bridge network, and 13.0-ohms resistance (9.3-ohm resistor +3.7 resistor) is in series with the sensor. The windshield anti-icing system will operate the same as described for LOW position, except for the following differences: Because there are 22.0 ohms less resistance in the control leg of the sensitive resistance bridge, the temperature sensor must attain a 22.0-ohm higher resistance value to balance the resistance bridge at 350.4 ohms. This will occur approximately 17.2 degrees C. or 31 degrees F. higher than the operating temperatures in the LOW position. The temperature controller will attempt to maintain the

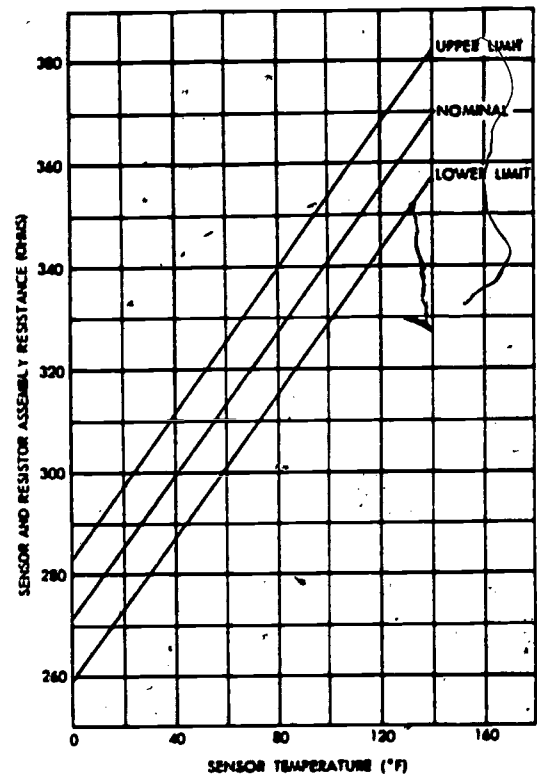


Figure 77. - Windshield anti-icing sensor resistance/temperature chart (high).

temperature of the windshield panels between approximately 42.2° and 45° C. (108° and 114° F.), which corresponds to sensor resistance of 337.4 and 341.1 ohms.

WINDSHIELD ANTI-ICING SYSTEM COMPONENTS

Temperature Controller

The temperature controller (figure 76, item 9) controls operating current to the heating elements in the windshield. The controller is a two-channel control (a separate channel for each windshield). Each channel contains a sensitive resistance bridge, amplifier, sensitive relay, and power relay. The resistance of sensors moulded in the electrapane windshield panels varies with changes in windshield temperature. The sensor is an integral part of the controller's resistance bridge circuit and, through its resistance changes, controls operation of the temperature controller by balancing or unbalancing the resistance

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bridge. Changes in the temperature controller's resistance bridge circuit vary the input signal to the controller's amplifier and, as a result, vary amplifier output. The amplifier output control relays connect or disconnect power to the heating elements in the windshield, thus controlling windshield temperature. The temperature controller also incorporates a filter to prevent radio interference.

Step-Up Transformers

The step-up transformers (figure 76, item 10), on a shelf in the electronics compartment directly behind the temperature controller, are used in the windshield anti-icing system. The step-up transformers increase output voltage from the controller from 115 volts AC to 230 volts AC (208 volts AC to 416 volts AC line to line) for operation of the electrapane windshield panel heating elements. One step-up transformer supplies power to each electrapane windshield.

Resistor Assembly

The resistor assembly on the overhead control panel controls the operating temperature of the windshield heating elements through their effect on the temperature controller's resistance bridge circuit. The assembly is made up of four resistors, two for the control of each windshield. With the WINDSHIELD ANTI-ICE switch at HIGH, one of the resistors is dropped from each sensor circuit and 9.3-ohms resistance is used, allowing the windshield heating elements to attain a higher temperature. In the LOW position, two resistors with a combined resistance of 31.3 ohms are placed in each sensor circuit to restrict the heating elements to a lower operating temperature.

ENGINE ANTI-ICING SYSTEM

The engine anti-icing system (figure 78) consists of two pilot-controlled, automatically regulated systems which prevent formation of ice on the oil tank mounting ring, engine air intake duct, inlet guide vanes, starter cover, and front frame of

each engine. Each engine anti-icing system consists of an oil tank mounting ring, engine air intake duct, and starter cover, one channel of a temperature controller, a control switch, a resistor, and a caution light.

The engine air intake duct contains heating elements (thermal electric boots), a temperature sensor imbedded between fiberglass laminations, and a thermal switch mounted externally on the fiberglass. The oil tank mounting ring, electrically interconnected with the engine air intake duct, contains a heating element (thermal electric boot). The engine-furnished solenoid controls hot compressor air flow through the engine front frame top and right struts to the inside of the starter fairing and inlet guide vanes. The engine front frame bottom strut is continuously heated by scavenge oil from the No. 1 bearing area. The engine front frame left, right, and top strut is continuously heated by the 10th-stage compressor air flow.

With the ENGINE ANTI-ICE switches positioned to ON, the #1 and #2 INLET ANTI-ICE caution lights warn the pilot of approaching icing conditions as engine air intake duct temperatures reach 37.8° C. (100° F.) or below. If ambient temperature is -18° C. (0° F.) or above and the engine anti-icing system is on, the caution panel lights coming on indicate anti-ice system failure. The caution/advisory #1 INLET ANTI-ICE and #2 INLET ANTI-ICE capsules are illuminated through the thermal switches on the intake ducts. Power is supplied by 28-volt DC PRI bus.

The inlet guide vane portion (subsystem) of each engine anti-icing system uses a portion of the ENGINE ANTI-ICE switch and consists of a solenoid control relay, a current sensing relay, and anti-icing solenoid valve (engine furnished), and a caution/advisory panel light capsule. Placing the ENGINE ANTI-ICE switch in the ON position opens the normally closed circuits to the engine solenoid to start the anti-icing system within the engine. At the same time the corresponding #1 or #2 ENG IGV ANTI-ICE light capsule on the caution/advisory panel will illuminate, providing the current sensing relay senses that the inlet guide vane (IGV) anti-icing system is on. The function of the current sensing relay is to indicate if the system is on or off. The solenoid control relay provides for

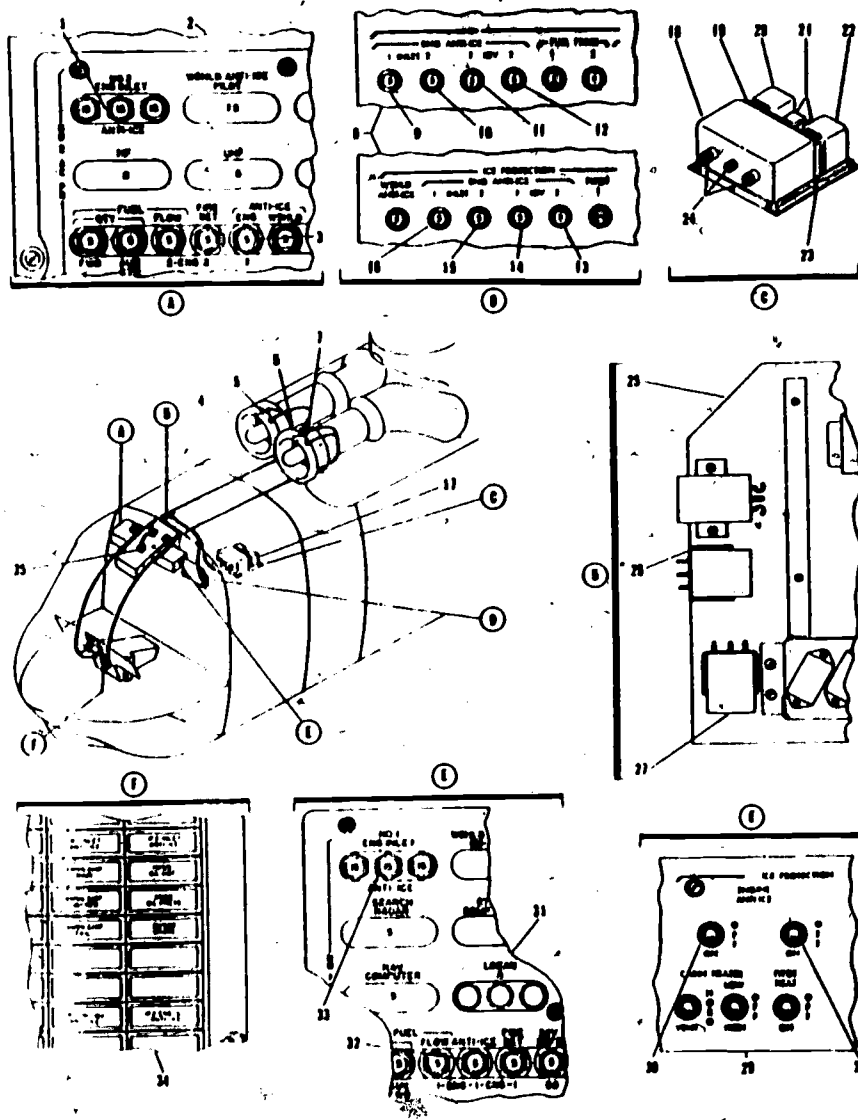


Figure 78. - Engine anti-icing system.

- 1 No. 2 AC Primary Circuit Breakers
- 2 Pilot's Circuit Breaker Panel
- 3 No. 2 AC Primary Circuit Breaker
- 4 Anti-Icing Duct (No. 2 Engine)
- 5 Anti-Icing Solenoid Valve
- 6 Anti-Icing Duct (No. 1 Engine)
- 7 Anti-Icing Solenoid Valve
- 8 Overhead Circuit Breaker Panel (DC Primary)
- 9 Circuit Breaker (Caution Light)
- 10 Circuit Breaker (Caution Light)
- 11 Circuit Breaker (Advisory Light)
- 12 Circuit Breaker (Advisory Light)

- 13 Circuit Breaker (Inlet Guide Vane)
- 14 Circuit Breaker (Inlet Guide Vane)
- 15 Circuit Breaker (Relay Power)
- 16 Circuit Breaker (Relay Power)
- 17 Temperature Controller
- 18 Filter Assembly
- 19 Amplifier
- 20 Relay
- 21 Sensitive Relays
- 22 Relay
- 23 Amplifier
- 24 Receptacles
- 25 Relay Panel

- 26 Anti-Ice Relay (No. 1 Engine HOV)
- 27 Anti-Ice Relay (No. 2 Engine HOV)
- 28 Switch (Inlet Duct and HOV)
- 29 Overhead Switch Panel
- 30 Switch (Inlet Duct and HOV)
- 31 Copilot's Circuit Breaker Panel
- 32 No. 1 AC Primary Circuit Breaker
- 33 No. 1 AC Primary Circuit Breakers
- 34 Caution/Advisory Panel
- 35 Relays (Solenoid Control)

Key to Figure 78.

proper functioning of the solenoid valve by de-energizing the solenoid valve when the ENG ANTI-ICE switch is in the ON position. When the ENGINE ANTI-ICE switch is in the OFF position, the solenoid valve is energized through the solenoid control relay and the current sensing relay is energized, breaking the circuit to the ENG IGV ANTI-ICE light capsule on the caution/advisory panel.

Operational Description

The thermal switches on the engine air intake duct close when the inlet throat temperature drops below 37.8°C . (100°F .), if the ENGINE ANTI-ICE 1 and 2 switches are positioned to ON. This will cause illumination of the caution/advisory panel #1 and #2 INLET ANTI-ICE light capsules. Simultaneously the temperature controller will attempt to maintain a duct temperature of approximately 82.2°C . (180°F .) and 87°C . (188°F .). The ENGINE ANTI-ICE 1 and 2 switches also open the circuits to the engine anti-ice solenoids to permit compressor air flow to warm the engine inlet guide vanes and the starter cover. The #1 and #2 ENG ANTI-ICE IGV light capsules on the caution/advisory panel will illuminate and remain on as long as the anti-icing system is on. The #1 and #2 INLET ANTI-ICE light capsules will go off when the intake duct temperature exceeds 37.8°C . (100°F .). If the ambient air temperature is -18°C . (0°F .) or below and the anti-ice system is on, the caution panel lights may come on indicating no anti-ice protection, as electrical heating may not be sufficient to maintain 37.8°C . (100°F .) under these conditions.

Engine Air Intake Duct Anti-Icing

Each temperature sensor, imbedded in the engine air intake duct, is connected to one channel of the temperature controller. The temperature sensor is a resistor which changes its resistance with temperature changes. A decrease in temperature causes a decrease in resistance. Conversely, an increase in temperature causes an increase in resistance. Each temperature sensor is wired as part of the control leg of a sensitive resistance bridge network in the temperature controller. A 3.7-ohm resistor is in series with the sensor, and

a 3.3K-ohm resistor is in parallel with the resistor. For a balanced bridge network, the control leg resistance should be 350.4 ohms. With the ENGINE ANTI-ICE switch in the ON position, excitation voltage is provided for the sensitive resistance bridge. The control leg resistance (sensor resistance plus 3.7-ohms) will be below 350.4 ohms; at 4.4°C . (40°F .) the control leg resistance is approximately 235 ohms. Due to the unbalanced condition of the bridge network, a differential voltage will be fed into the amplifier. The output of the amplifier is rectified voltage that energizes the sensitive relay. The 3.7-ohm resistor is shunted by the normally open contacts of the sensitive relay to drive the bridge network further out of balance and ensure positive relay closing. Another set of normally open contacts of the sensitive relay provides a path for 28 volts DC to energize the power switching relay. With the power relay energized, three-phase 115 volts AC is applied to the anti-icing duct heating elements.

Temperature Control

As the temperature of the engine air intake anti-icing duct increases, the caution/advisory panel #1 or #2 INLET ANTI-ICE light capsules will go off when the duct temperature exceeds 37.8°C . (100°F .). The temperature of the duct will continue to increase until the bridge network is balanced by a control leg resistance of 350.4 ohms. The resistance of the temperature sensor in parallel with the 3.3K resistor will be 350.4 ohms at approximately 87°C . (188°F .). With no differential voltage applied to the amplifier, the sensitive relay de-energizes, causing the power relay to also de-energize, removing power from the heating elements. With the sensitive relay de-energized, the 3.7-ohm resistor is added to the resistance of the control leg, which now totals 354.1 ohms. The sensitive relay cannot now be energized until the control leg resistance is below 350.4 ohms (sensor resistance of 346.7 plus 3.7 ohms). The resistance of the temperature sensor in parallel with a 3.3K resistor will be 346.7 ohms at approximately 82.2°C . (180°F .). The temperature controller will attempt to maintain the duct temperature between 82.2° and 87°C . (180° and 188°F .).

Engine Inlet Guide Vane Anti-Icing

The inlet guide vane anti-icing system will remain on as long as the ENGINE ANTI-ICE switch is in the ON position. The engine anti-ice solenoid is spring loaded open, and in the event of an electrical failure, the IGV anti-ice system will be on.

ENGINE ANTI-ICING SYSTEM COMPONENTS

Engine Anti-Icing Ducts

The engine anti-icing ducts (figure 78, items 4 and 6), at the front frame of the demountable power plant, direct air into the engine compressor section. Each engine anti-icing duct contains heating elements, a temperature sensor imbedded between the fiberglass laminations, and a thermal switch mounted externally on the fiberglass laminations.

Temperature Controller

The temperature controller (figure 78, item 17) controls operating current to the heating elements and permits independent temperature control for each duct. The unit is a dual-channel controller with each channel controlling one anti-icing duct. Each channel contains a sensitive resistance bridge circuit, an amplifier, a sensitive relay, and a power relay. Electrical power through the temperature controller bridge circuit is varied due to resistance changes in the temperature sensor on the engine

anti-icing duct. This electrical power is amplified and actuates the relays regulating three-phase power to the duct heating elements. Power to the heating elements is removed if the associated sensor circuit is open or shorted. The temperature controller also incorporates a filter assembly to prevent radio interference.

Solenoid Control Relay

The two solenoid control relays on the overhead control panel provide for proper operation of the engine solenoid valves by de-energizing each valve when the corresponding ENGINE ANTI-ICE switch is ON. When the switch is OFF, the solenoid control relay is de-energized, and the engine solenoid valve is energized through the normally closed contacts of the relay.

Current Sensing Relay

Two inlet anti-ice relays are mounted on the relay panel on the forward cabin bulkhead. The anti-ice relays are current sensing relays, whose function is to indicate when the anti-icing system for each engine is on or off. When an engine anti-icing system is turned on, the corresponding engine anti-ice solenoid valve is de-energized, and the current sensing relay, sensing this condition, is de-energized also. The normally closed contacts of the current sensing relay provide power to illuminate the #1 or #2 ENG IGV ANTI-ICE light capsules on the ADVISORY PANEL.

REVIEW

This section has covered the heating, ventilating, and anti-icing systems. You will need to understand these systems before you can pre-flight an aircraft.

(Now answer the following review questions.)

62. The heater cycling valve is controlled by a/an _____ switch. 62.-B (Refer to page 117)
- A. air pressure
 - B. thermal
 - C. manual
 - D. fuel pressure
63. The blower relay is energized by the _____. 63.-C (Refer to page 119)
- A. overheat relay
 - B. ignition control time delay relay
 - C. 120° F. thermal switch
 - D. 93.3° C. thermal switch
64. The heater in an HH-3F can produce a MAXIMUM of _____ BTU. 64.-D (Refer to page 119)
- A. 100,000
 - B. 150,000
 - C. 175,000
 - D. 200,000
65. Heater fuel is taken from the _____ fuel tank. 65.-A (Refer to page 121)
- A. forward main
 - B. forward aux
 - C. aft main
 - D. aft aux
66. Which of the following serves as a safety valve to prevent overheating of the heater? 66.-C This valve shuts off fuel to the heater in case of an overheat condition. (Refer to page 122)
- A. Vent valve
 - B. Cycling valve
 - C. Master fuel valve
 - D. Exhaust temperature sensing valve
67. What is the purpose of the 140.6° C. thermal switch in the plenum chamber? 67.-B This switch acts as a thermostat. (Refer to page 123)
- A. De-energize the overheat relay
 - B. Regulate the heating system temperature
 - C. Energize the blower relay
 - D. Actuate the ignition sensing control relay

68. The temperature sensors for the windshield anti-ice system are located _____.

- A. between the windshield plate glass laminations
- B. on the instrument panel, adjacent to the windshield
- C. in the cockpit overhead, adjacent to the windshield
- D. on the outside and inside surfaces of the windshield

69. The windshield heating elements attain a higher temperature in HIGH operation than in LOW operation because the _____.

- A. resistance is higher in the control leg of the bridge
- B. resistance is lower in the control leg of the bridge
- C. current required to actuate the sensitive relay is lower
- D. resistance bridge is balanced in HIGH operation but not in LOW operation

70. To prevent radio interference, the windshield temperature controller incorporates a _____.

- A. sensor
- B. diode
- C. resistor
- D. filter

71. Which components are anti-iced by thermal electric boots?

- 1. Oil tank mounting ring
- 2. Engine air intake duct
- 3. Inlet guide vanes
- 4. Starter cover

- A. 1 and 2 only
- B. 2 and 3 only
- C. 3 and 4 only
- D. 1, 2, and 3

72. When the control switch is placed in the ON position, the engine air intake duct will be anti-iced anytime the temperature drops below _____.

- A. -18° C.
- B. 37.8° C.
- C. 82.2° C.
- D. 87° C.

68.-A (Refer to page 123)

69.-B (Refer to page 123)

70.-D (Refer to page 126)

71.-A (Refer to page 126)

72.-B (Refer to page 129)

73. The function of the engine anti-ice current sensing relays is to _____

73.-C (Refer to page 130)

- A. measure the temperature at the front frame of each engine
- B. control current to the heating elements of each engine anti-icing duct
- C. indicate when the engine anti-ice system is on or off
- D. control the hot air directed into the engine compressor section

HH-3F FUEL SYSTEM

OBJECTIVES

When you complete this section, you will be able to:

1. Summarize the operation of the HH-3F fuel system.
2. Identify fuel system components and explain their function.
3. Describe the fuel dumping system.
4. Explain the pressure refueling system.
5. Describe the fuel transfer system.

As a flight mechanic on the HH-3F, you must be familiar with the aircraft fuel system as well as the engine fuel system. The following paragraphs cover a typical HH-3F aircraft fuel system, its components, and principles of operation.

GENERAL DESCRIPTION

(See figures 79 and 80.)

The system is an open vent type which consists of main and auxiliary fuel tanks, a fuel management panel, boost pumps, boost pump relays, pressure switches, valves, filters, collectors, mixing chambers, fuel ejector units, and tank unit probes. When normal fuel system operation is desired, the forward and aft main tanks boost PUMP 1 and 2 and the fuel shutoff valves switches are positioned to ON. This permits fuel, under boost pump pressure, to pass through the filters to the engines. Fuel from the forward main tank supplies No. 1 engine, and the aft main tank supplies No. 2 engine. No. 1 engine filter is on the right side, and No. 2 engine filter is on the left side of the fuselage. Should either filter become clogged, the filter bypass valve will open and the caution/advisory panel FWD or AFT FUEL BYPASS light capsule will illuminate. If a boost pump should fail, the appropriate FAIL light will illuminate. If fuel pressure should drop below -4.6 to -5.1 psi, the appropriate LOW PR light will illuminate.

The engines may be efficiently operated with one, both, or no boost pumps. However, it is necessary to operate the helicopter with at least one boost pump operating in each main tank during the following conditions:

1. Above 6000 feet pressure altitude
2. Dumping fuel

3. Above 43 degrees Centigrade fat
4. Transferring fuel
5. Below 600 pounds of fuel per tank
6. Whenever a fuel filter bypass is illuminated.
7. Whenever a fuel low pressure caution light is illuminated
8. One pump per tank during takeoff and landing

NOTE

Continuous use of one boost pump per engine is mandatory to prevent inadvertent operation without boost pumps when the exceptions are encountered. Actual or simulated generator failure will cause loss of both number two boost pumps.

Fuel flow to either engine may be stopped by pulling the appropriate FIRE EMER SHUT OFF SELECTOR handle on the overhead control panel, or by positioning the appropriate fuel shutoff valve switch to OFF. If necessary, fuel may be supplied to one engine from both tanks by opening one fuel shutoff valve and the crossfeed valve, or to both engines from one tank by opening both fuel shutoff valves and the crossfeed valve. The fuel tanks may be gravity or pressure refueled. When pressure refueling is used, system shutoff capabilities are tested at the start of the operation. Fuel may be transferred from the auxiliary fuel tanks to the main fuel tanks by using boost pump pressure, fuel transfer valves, and fuel ejector units. Fuel may be offloaded from the helicopter by positioning either manual defueling valve handle in the open position.

All component switches and indication lights are on the fuel management panel. When 30 minutes of fuel or less remains in the main tanks, the caution/advisory panel FWD FUEL LOW and AFT FUEL LOW light

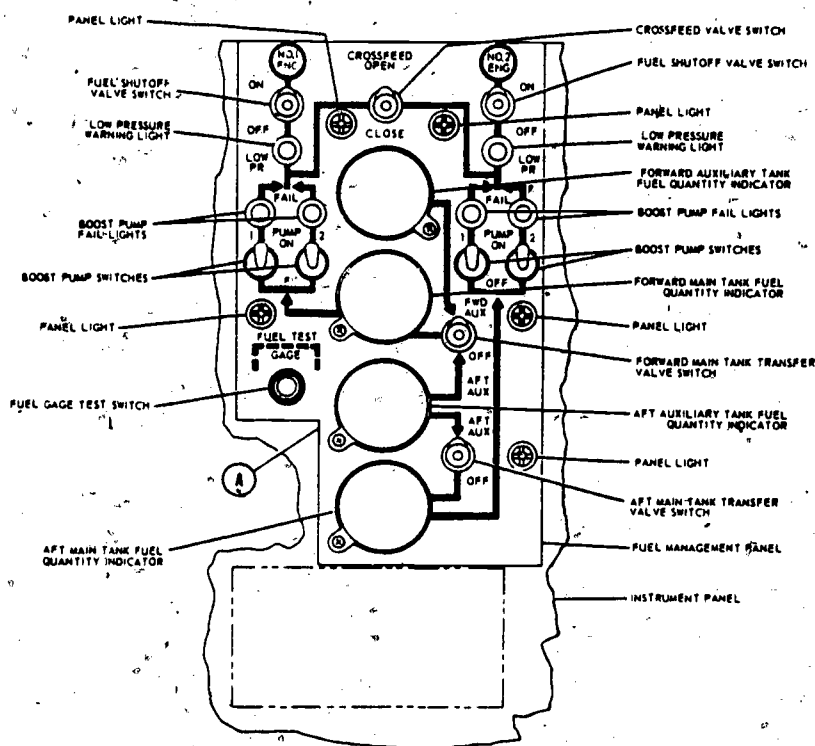


Figure 79. - Fuel management panel.

capsules will illuminate. Fuel for the cabin heater is supplied by the forward main tank, and fuel for the APU is supplied by the aft tank.

SYSTEM COMPONENTS

FUEL MANAGEMENT PANEL (See figure 79.)

The fuel management panel on the upper center portion of the instrument panel consists of fuel quantity indicators, indicator lights, panel lights, and switches. The fuel quantity indicators indicate the fuel quantity of the main and auxiliary fuel tanks. The indicator lights indicate boost pump failure and low fuel pressure. The panel lights illuminate the panel for night operations. The switches control the operation of the crossfeed valve, fuel shutoff valves, fuel transfer valves, and boost pumps. Also, a test switch is used to check the operation of the fuel quantity indicator.

FUEL SHUTOFF VALVE (See figure 80.)

Two valves on the cabin ceiling aft of the personnel door control fuel flow to each engine. Each valve is a motor-operated valve controlled by the fuel shutoff

valve switch on the fuel management panel and the FIRE EMER SHUTOFF SELECTOR handle on the overhead control panel. Normal fuel flow is accomplished by positioning the fuel shutoff valve switches to ON. This permits electrical power to flow from the 28-volt DC primary bus through the normally closed pole of the FIRE EMER SHUTOFF SELECTOR handle switch, through the ON-OFF switch on the fuel management panel to the valve. The fuel shutoff valves may be closed by positioning the fuel shutoff valve switches to OFF or by actuating the FIRE EMER SHUTOFF SELECTOR handle. The handle closes the normally open fire emergency selector handle switch and directs electrical power to the valve. During crossfeed operations, fuel may be directed to one engine from both tanks by positioning the CROSSFEED switch to OPEN and closing one of the fuel shutoff valves.

CROSSFEED VALVE (See figure 81.)

The valve on the cabin ceiling, aft of the personnel door, is a motor-operated valve controlled by the CROSSFEED switch on the fuel management panel. Positioning the CROSSFEED switch to OPEN interconnects fuel flow of the aft and forward main fuel tanks. Should unequal fuel levels exist

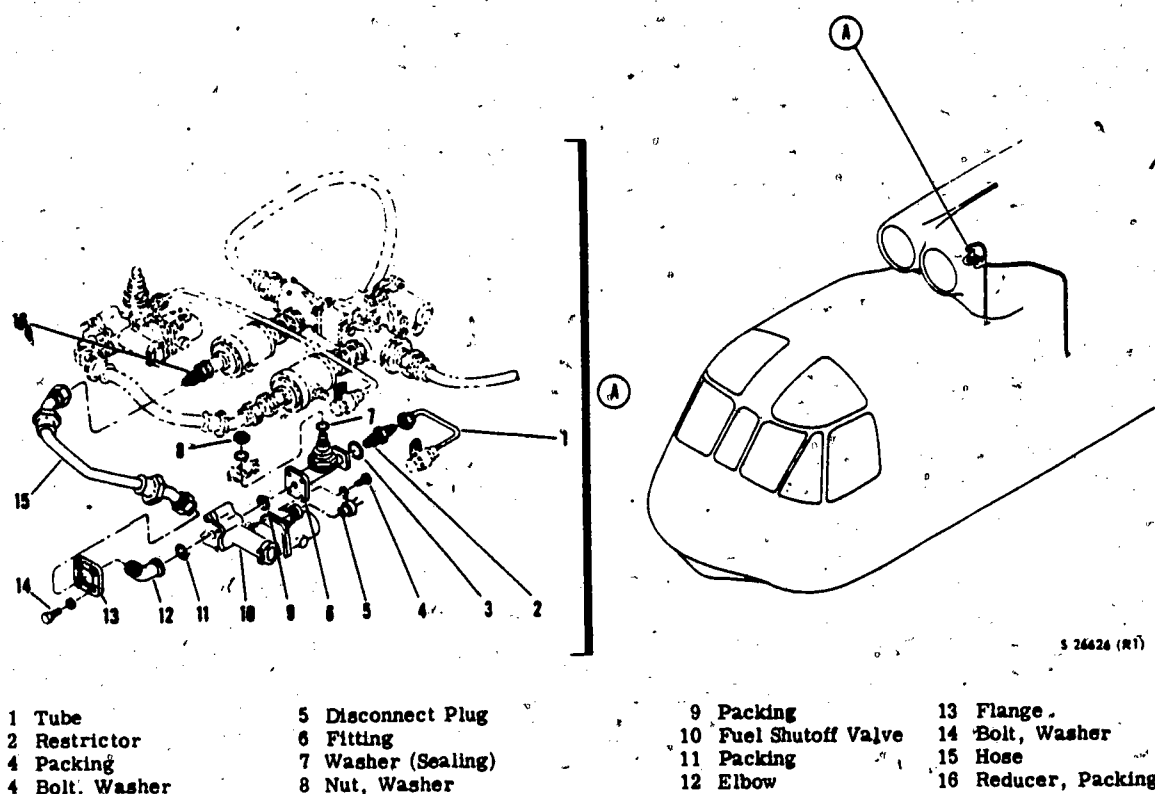


Figure 80. - Fuel shutoff valve.

between fuel tanks or should fuel boost pumps fail in either tank, operation of the crossfeed valve switch in conjunction with the fuel shutoff valves and fuel boost pump switches enable various combinations of fuel selections to one or both engines from either tank. When the crossfeed valve opens, check valves prevent fuel from feeding back into the inoperative fuel tank. The CROSSFEED switch is positioned to CLOSE during normal operation.

NOTE

When securing cross-feed operation turn on a boost pump in the tank not being used prior to closing the cross-feed switch.

MAIN FUEL LINE

(See figure 82.)

The No. 1 and No. 2 engine main fuel lines are the same except that the No. 1 engine main fuel line is installed on the right side of the cabin interior and the No. 2 engine main fuel line is installed on the left side of the cabin interior.

FUEL FILTER

(See figures 82 and 83.)

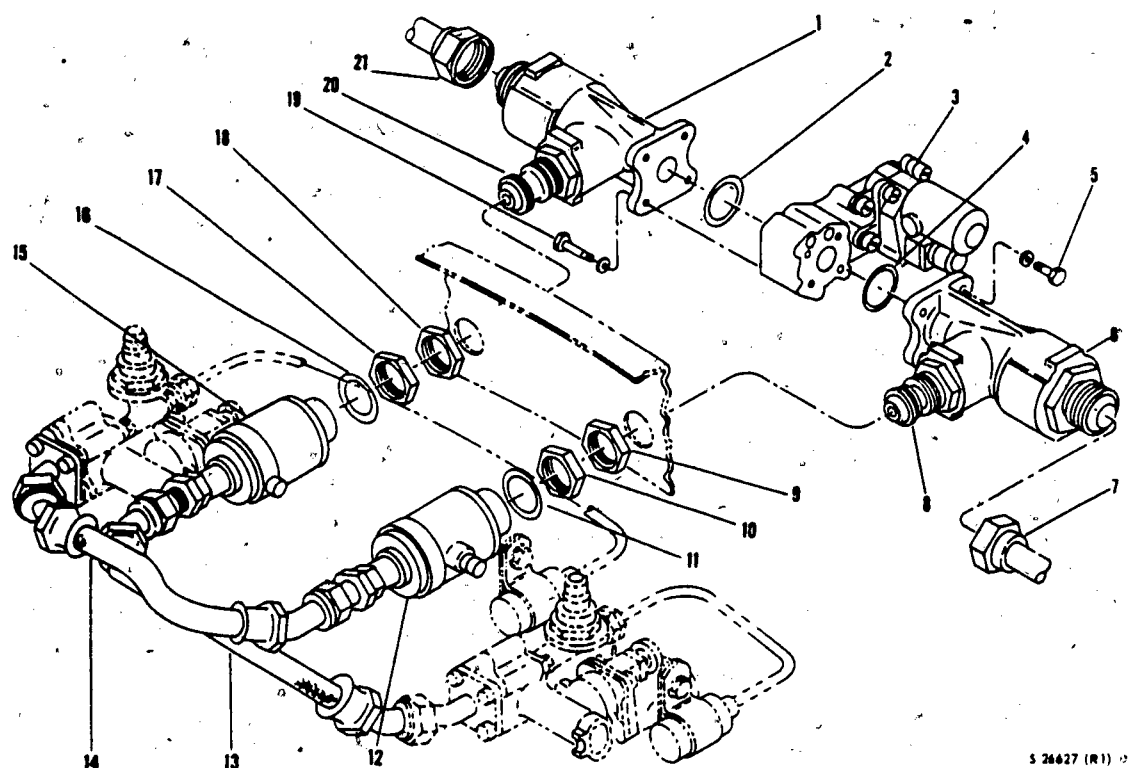
The fuel filters, one on each side of the fuselage, each consist of a housing, built-in bypass valve, packing, bowl, and

a paper or metal filter element. The bypass valve allows fuel to bypass a partially clogged filter if a pressure differential of 2.1 psi occurs. In addition, the applicable FWD or AFT FUEL BYPASS light capsules on the caution/advisory panel should illuminate. However, it is possible to have the light illuminate without fuel being bypassed due to a partially clogged fuel filter. Filter elements must be cleaned or replaced when the applicable FWD or AFT FUEL BY-PASS light capsules illuminate.

FORWARD MAIN FUEL TANK

(See figures 83 and 84.)

The tank is in the lower fuselage and consists of two bladder cells. The cells are interconnected by flanged holes in the cell walls. Each cell is vented at two places and is connected by fittings and tubes to vent fittings secured to each side of the fuselage. The forward cell contains a collector, defueling valve, sump drain valve, fueling valve, high level shutoff valve, level control valve, and a fuel quantity tank unit probe. The aft cell contains a fuel ejector unit, sump drain valve, level control valve, and a fuel quantity tank



- 1 Housing (Check Valve)
- 2 Packing
- 3 Crossfeed Valve
- 4 Packing
- 5 Bolt, Washer
- 6 Housing (Check Valve)

- 7 Tube
- 8 Union
- 9 Nut
- 10 Nut
- 11 Packing

- 12 Transmitter
- 13 Hose
- 14 Hose
- 15 Transmitter
- 16 Packing

- 17 Nut
- 18 Nut
- 19 Bolt, Washer
- 20 Union
- 21 Tube

Figure 81. - Crossfeed valve.

unit probe. An access cover for each cell is installed on the floor panel covering the cell. A filler cap and adapter secured to the scupper at the left side of the forward cell permit gravity re-fueling of the tank.

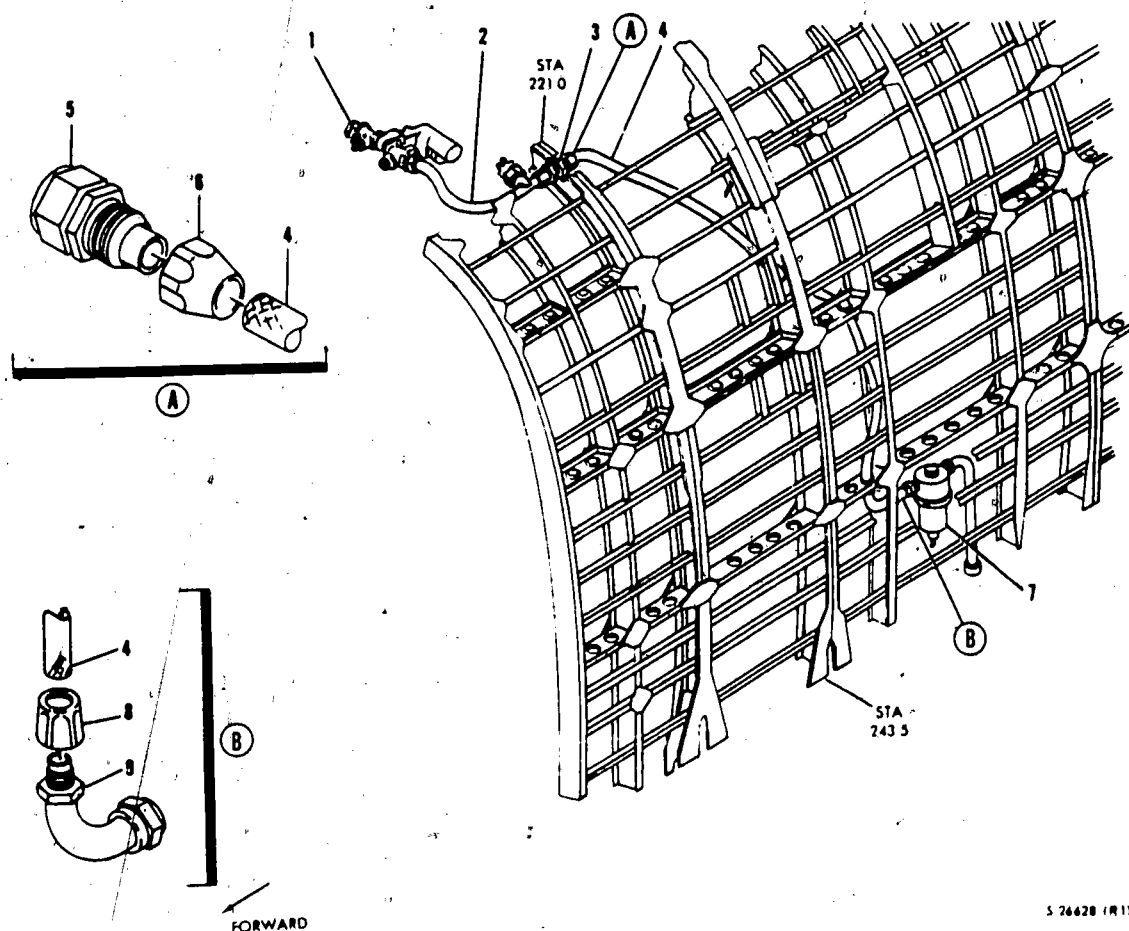
AFT MAIN FUEL TANK (See figures 83 and 84.)

The tank is in the aft portion of the lower fuselage and consists of two bladder cells. The cells are interconnected by flanged holes in the cell walls. Each cell is vented at two places and is connected, by fittings and tubes, to vent fittings secured to each side of the fuselage. The forward cell contains a collector, manual-defueling valve, sump drain valve, pressure fueling

valve, high level shutoff valve, level control valve, and a fuel quantity tank unit probe. The aft cell contains a fuel ejector unit, sump drain valve, and fuel quantity tank unit probe. An access cover for each cell is installed on the floor panel covering the cell. A filler cap, adapter, and filler tube are secured to the scupper forward of the tank and connected to the forward side of the forward cell to permit gravity refueling of the tank.

FORWARD AUXILIARY FUEL TANK (See figures 83, 84 and 88.)

The tank is in the forward portion of the lower fuselage and is a bladder-type, single-cell tank. The tank is vented at three places and is connected, by fittings and tubes, to vent fittings secured to each



1 Crossfeed Valve
2 Tube
3 Union, Nut

4 Main Fuel Line
5 Fitting

6 Sleeve
7 Fuel Filter

8 Sleeve
9 Fitting

Figure 82. - Main fuel lines.

side of the fuselage. The tank contains a pressure fueling valve, manual defueling valve, sump drain valve, high level shutoff valve, fuel ejector unit, and a fuel quantity tank unit probe. An access cover is installed on the floor panel covering the tank. A filler cap and adapter secured to a scupper at the left side of the tank permit gravity refueling of the tank. A pressure refueling valve adapter is installed on the right side of the tank.

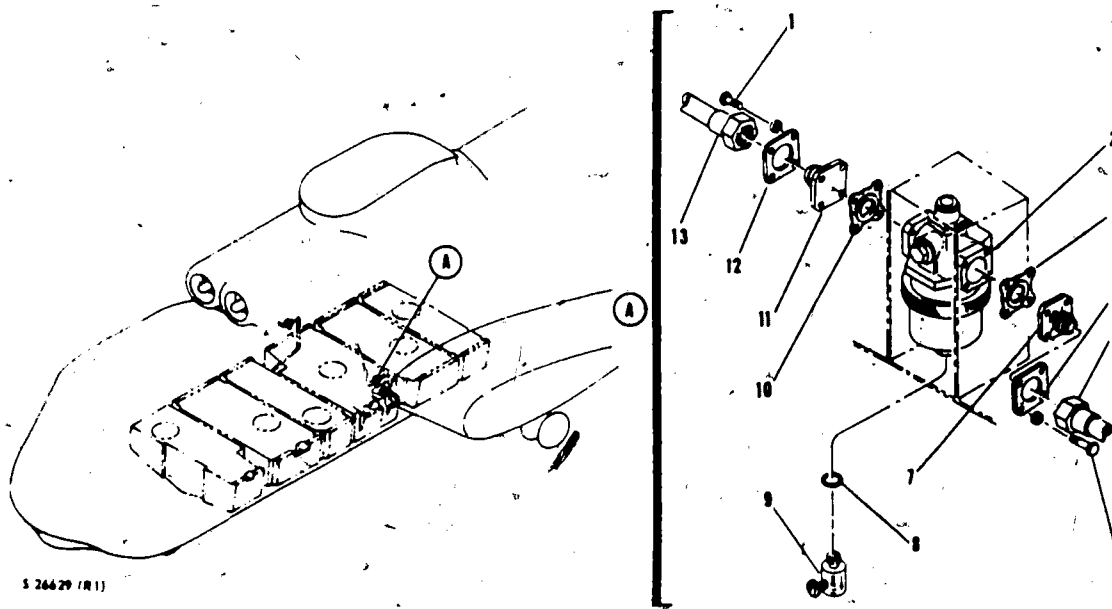
AFT AUXILIARY FUEL TANK. (See figure 87.)

The tank is in the lower fuselage, between the main tanks, and is a bladder-

type, single-cell tank. The tank is vented at three places and is connected, by fittings and tubes, to vent fittings secured to each side of the fuselage. The tank contains a pressure fueling valve, manual defueling valve, sump drain valve, high level shutoff valve, two fuel ejector units, and a fuel quantity tank unit probe. An access cover is installed on the floor panel covering the tank. A filler cap and adapter secured to a scupper at the left side of the tank permit gravity refueling of the tank.

FUEL TANK VENTS

The vents connect the fuel tanks to atmosphere on both sides of the upper fuse-



- 1 Bolt, Washer
- 2 Filter
- 3 Seal
- 4 Gasket
- 5 Tube
- 6 Bolt, Washer
- 7 Connector

- 8 Gasket
- 9 Drain Valve
- 10 Seal
- 11 Connector
- 12 Gasket
- 13 Tube

Figure 83. - Fuel filter.

lage. The overboard fuselage vent openings are covered by a fairing which has an opening in the aft end. The fairing prevents air from the helicopter's forward motion from being forced into the fuel tanks.

COLLECTORS (See figure 84.)

A collector is in the forward cell of each main fuel tank. Each collector consists of two boost pumps, three check valves, a strainer, a fuel mixing chamber, and a flap valve. A hole in the bottom of the collector permits fuel to be drained during defueling.

FUEL BOOST PUMPS (See figure 85.)

Two pumps on the forward inside wall of each collector in the forward cell of

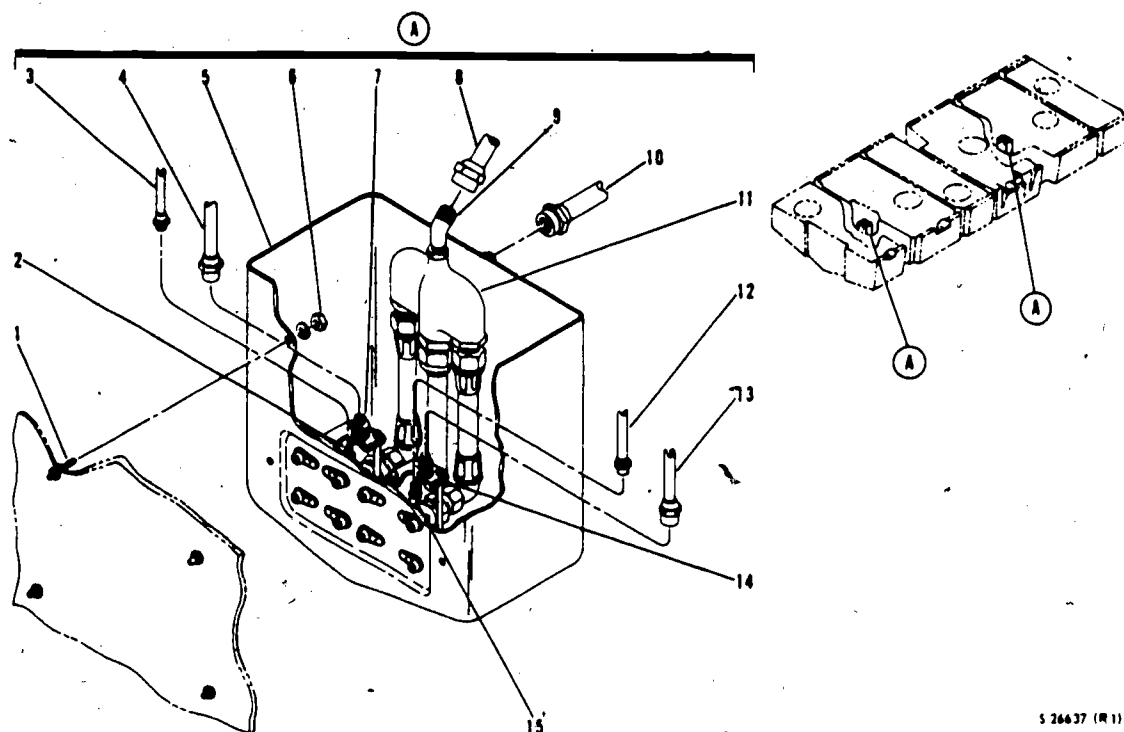
the forward and aft main tanks supply fuel to the mixing chambers, which simultaneously direct fuel to the engines and fuel ejector units. The fuel ejector units, installed in the aft fuel cells of each main tank, supply fuel to the collectors when the fuel pumps are operating.

FUEL BOOST PUMP RELAYS

Four plug-in-type relays, screwed to the cabin relay panel on the forward left cabin ceiling, control the operation of the fuel boost pumps. When the PUMP switches on the fuel management panel are positioned to ON, the relays are energized. This permits 115 volts AC to operate the fuel boost pumps.

FUEL MIXING CHAMBER (See figure 85.)

The chamber is installed in each collector in the forward cell of the forward



S 26637 (R 11)

- | | | | |
|------------------------|---------------|-----------------------|-------------------------|
| 1 Studs | 5 Collector | 9 Elbow, Nut, Packing | 13 Conduit (Electrical) |
| 2 Restrictor, Packing | 6 Nut, Washer | 10 Tube | 14 Boost Pump |
| 3 Tube | 7 Boost Pump | 11 Mixing Chamber | 15 Restrictor, Packing |
| 4 Conduit (Electrical) | 8 Tube | 12 Tube | |

Figure 84. - Collector.

and aft main fuel tanks. It discharges fuel to the engine and also provides a positive fuel pressure to the fuel ejector unit installed in each aft cell. The ejector unit then picks up the fuel in the aft cell and discharges it through a tube to the collector.

CHECK VALVES (See figure 85.)

A check valve is in each mixing chamber inlet port and in the engine fuel supply line. If only one boost pump is in operation, the check valves in the mixing chamber ports prevent fuel flow from entering the inoperative boost pump and strainer. The check valve in the engine supply line prevents fuel from feeding into the opposite tank during crossfeeding. The fuel shutoff valve prevents fuel from draining back into the tank.

FLAP VALVE (See figure 85.)

A flap valve, secured to the bottom inside surface of each collector, prevents discharge of fuel from the collector but allows fuel to enter the collector during a nose-down flight attitude. Under these conditions, the valve traps fuel to permit nose-up maneuvers during low fuel conditions.

FUEL EJECTOR UNITS (MAIN TANKS) (See figure 86.)

The fuel ejector unit in each main fuel tank aft cell transfers fuel from the aft cell to the collector in the forward cell. A line from the boost pump supplies fuel to the base of the ejector unit passing fuel through a restricted throat. This increases fuel velocity while decreasing pressure, thus syphoning the aft cell fuel.

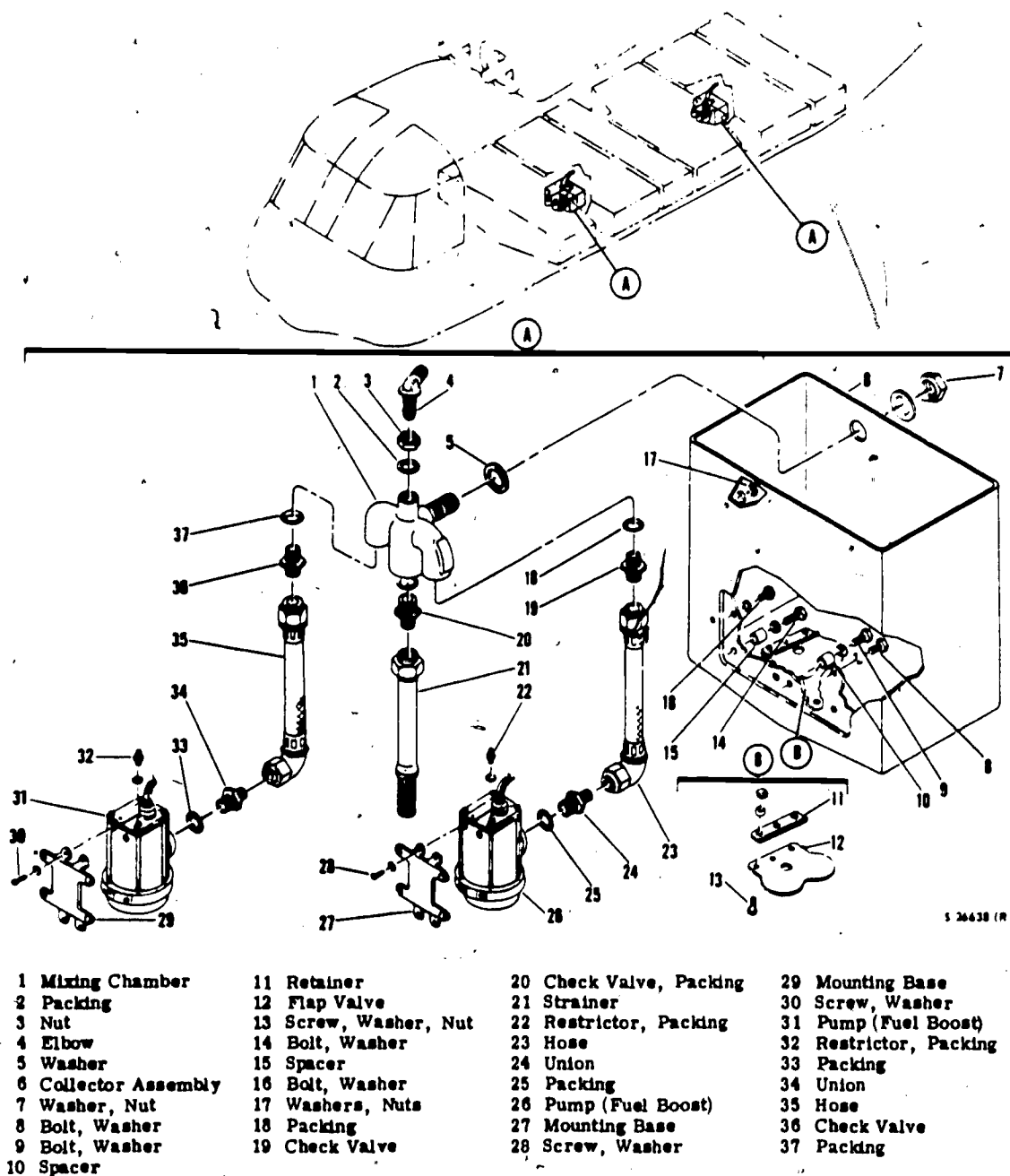
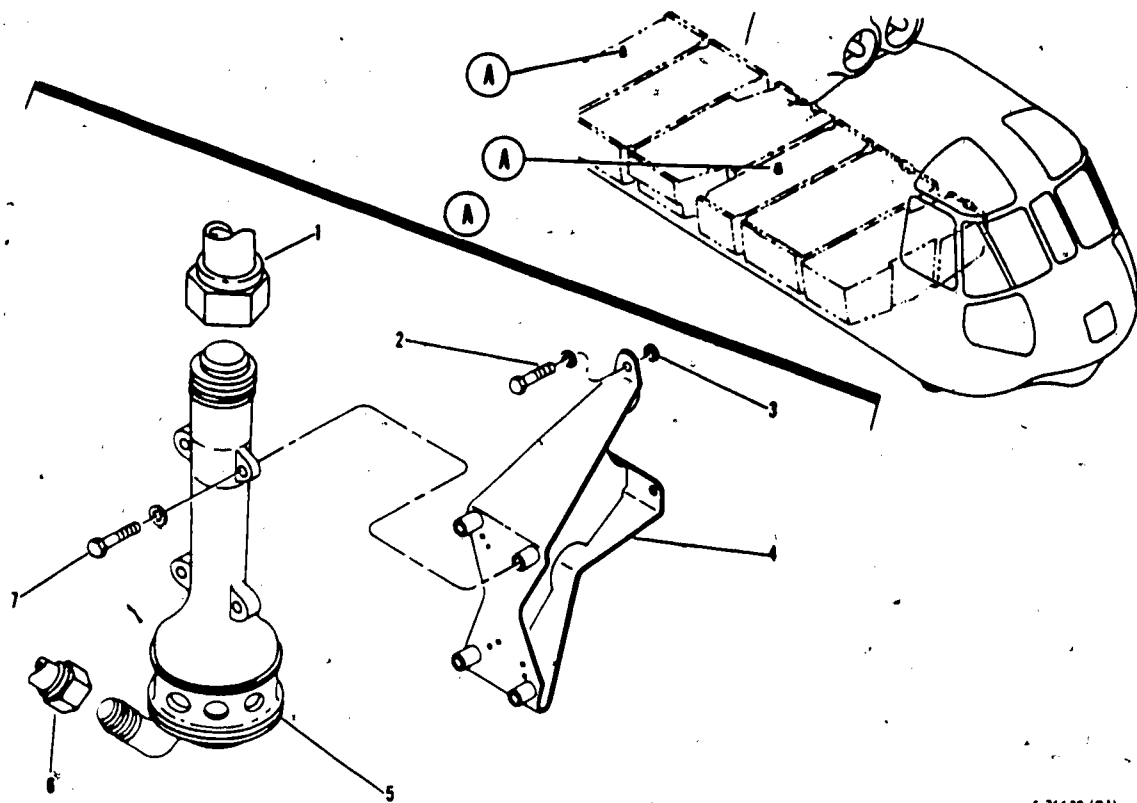


Figure 85. - Fuel boost pump.

A check valve is in the inlet line of each unit to prevent air from entering the engine fuel supply line if the boost pumps should fail and the fuel level should drop below the unit inlet.

PRESSURE SWITCHES

Four pressure switches, two mounted on the right forward corner of the aft auxiliary fuel tank and two on the aft left corner, are actuated by boost pump pressure. The pressure switches are marked 1 or 2 to correspond with the boost pump they operate in conjunction with. Each switch indicates boost pump failure by illuminating



S 26639 (R1)

- 1 Tube
- 2 Bolt, Washer
- 3 Washer (Sealing)

- 4 Support (Fuel Ejector)
- 5 Fuel Ejector Unit

- 6 Tube
- 7 Bolt, Washer

Figure 86. - Main fuel tanks fuel ejector units.

the appropriate PUMP FAIL light on the fuel management panel when pump pressure falls below 16-17 psi.

SUMP DRAIN VALVE (See figure 93.)

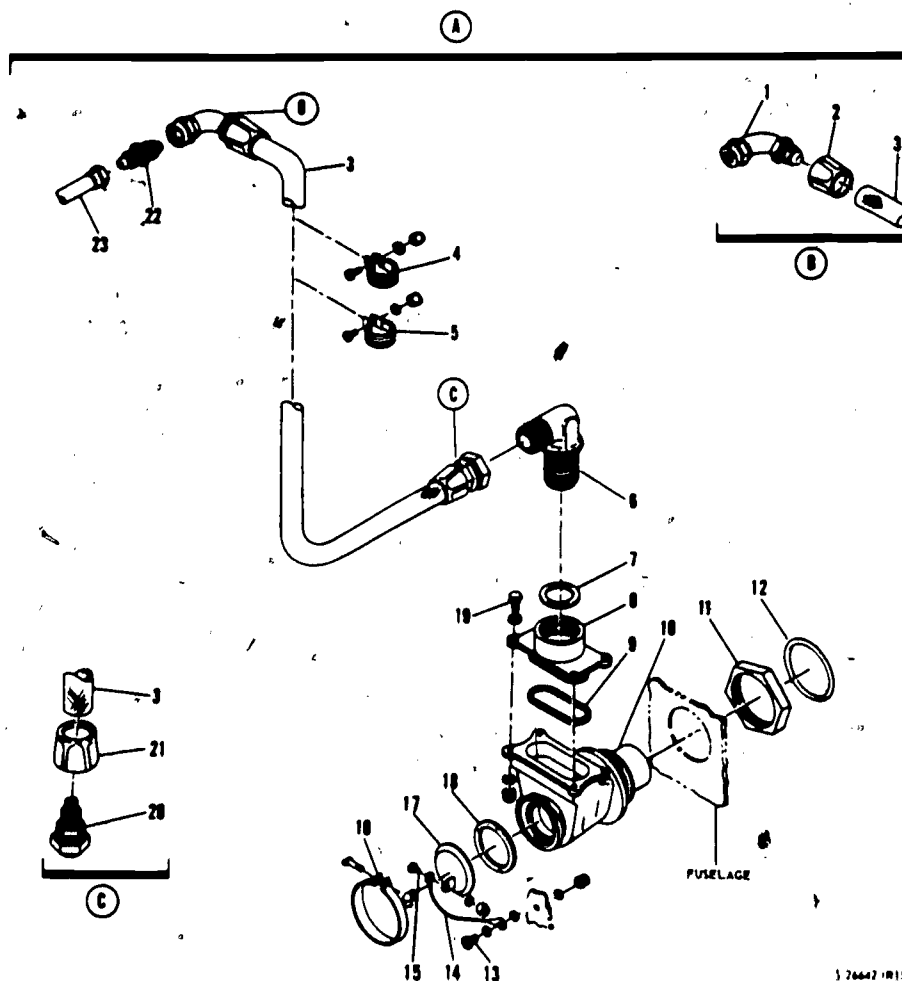
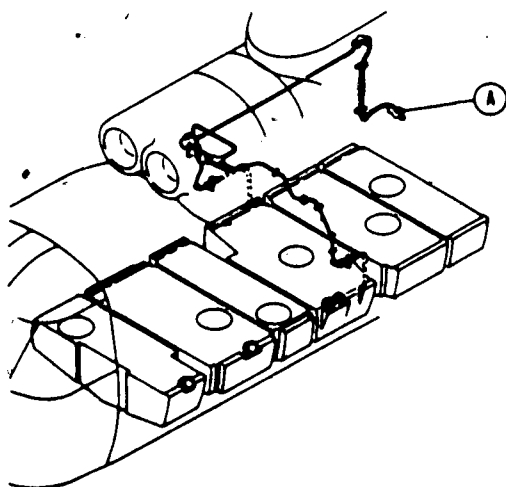
A poppet drain valve in each fuel cell sump is used to drain water from the bottom of each fuel cell. Each valve, secured to the bottom fuselage, consists of a valve body, spring, poppet, and guide. The poppet is kept closed by the spring contained within the body by the guide. The valve is opened by inserting a screwdriver in the slot in the poppet and pushing up with a force of $6.0 \pm .5$ pounds. The valves may be locked in the OPEN position by pushing up and turning the poppet to the right.

DEFUELING VALVES (See figure 93.)

A defueling valve, secured to the bottom of each main tank forward cell and auxiliary tank, permits gravity defueling of the tanks. To drain fuel from the tanks, remove the valve access cover on the lower fuselage and attach a hose to the valve. Then turn the valve handle and hold it in the open position until the desired amount of fuel is drained.

FUEL DUMPING SYSTEM

The system consists of two manually operated dump valves, a dump fitting, and associated tubing. (See figure 87.) When fuel dumping is desired, the boost pumps and crossfeed valve are actuated, and the



5 26642 (R11)

Figure 87. - Dump fitting and hose.

dump valves handles are turned to the OPEN position. This directs fuel from the engine supply lines through the tubing, dump fit-

ting, and right sponson to atmosphere. Fuel dumping is one of the flight mechanic's duties.

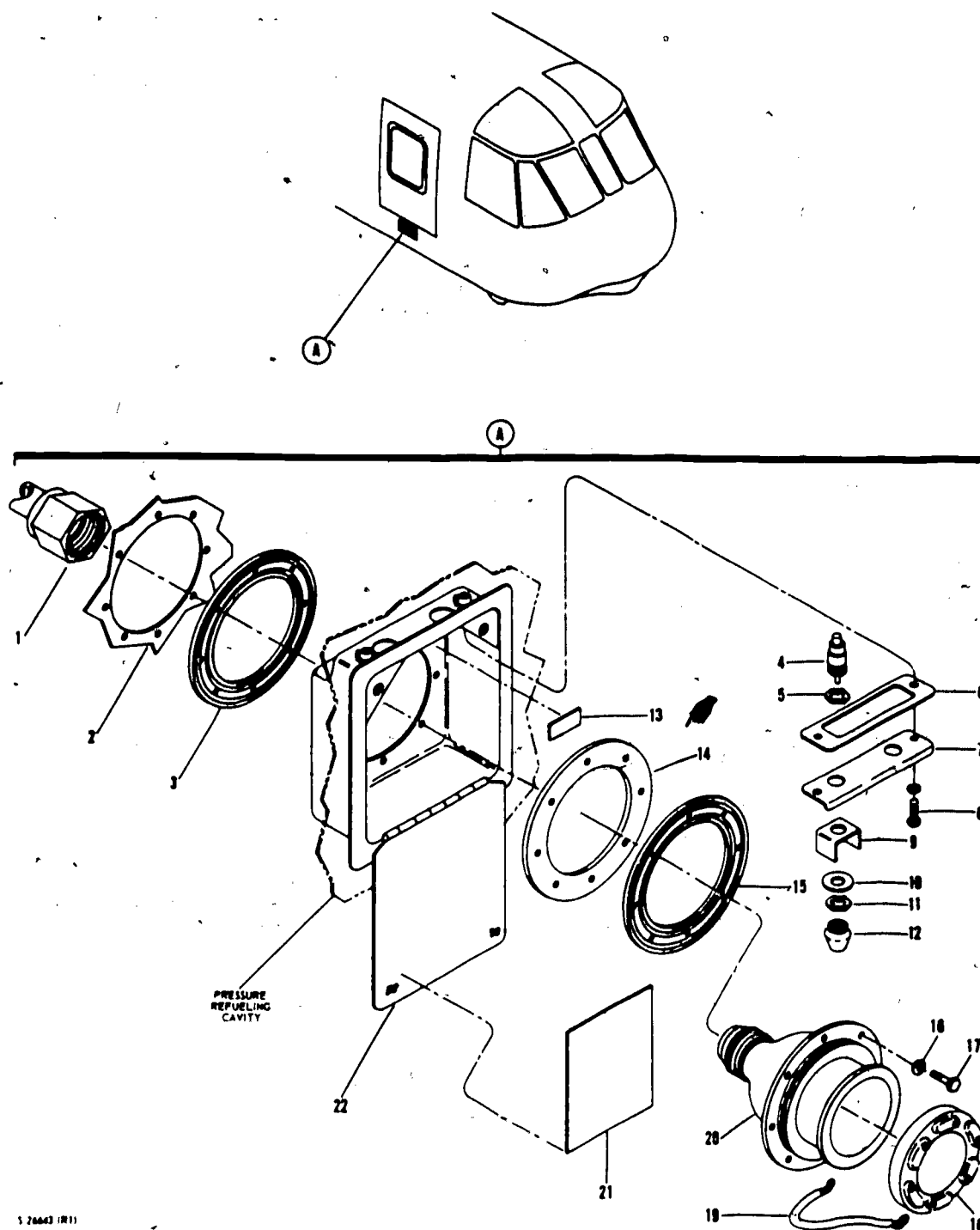


Figure 88. - Valve adapter and high level shutoff switches.

FUEL DUMP VALVES (See figure 87.)

The manually operated valves on the cabin ceiling are connected to the fuel

supply lines of each engine. The valves are spring loaded, closed, and secured with copper shearwire. When fuel dumping is desired, the shearwire is broken, and the valve handles are turned to OPEN until the desired amount of fuel has been dumped.

FUEL DUMP FITTING
(See figure 87.)

The fitting is at station 362 and water line 108 and consists of a housing and flap

valve. The flap valve prevents dumped fuel from the dump system from entering the cabin auxiliary fuel tanks when they are installed.

REVIEW

In this section we have discussed the fuel system in general, the fuel management panel, and various fuel system components.

(Now answer the following review questions.)

74. Which statement concerning the HH-3F fuel system is TRUE?

- A. The Number 1 engine is supplied by the aft main tank
- B. The Number 2 engine fuel filter is mounted on the right-hand side of the fuselage
- C. It is possible to supply both engines from one main tank
- D. APU fuel is supplied from the forward main tank

74.-C

Both engines can be supplied from one main tank by opening both fuel shutoff valves and the crossfeed valves. (Refer to page 135)

75. The fuel filter bypass valve allows fuel to bypass a clogged filter if a differential pressure of _____ psi occurs.

- A. 2.0
- B. 2.1
- C. 2.2
- D. 2.3

75.-B

This valve allows fuel to flow to the engine even though the filter is clogged. (Refer to page 137)

76. Which component(s) is/are found only in the aft cell of each main tank?

- 1. Ejector
- 2. Collector
- 3. High level shut-off valve
- 4. Fuel quantity tank unit probe

- A. 1 only
- B. 1 and 2 only
- C. 2 and 4 only
- D. 3 and 4 only

76.-A

(Refer to page 137)

77. The pressure refueling valve adapter is installed in the _____ tank.

- A. forward aux
- B. aft main
- C. forward main
- D. aft aux

77.-A

(Refer to page 139)

78. A positive pressure to each ejector is provided by the _____ in the collector.

- A. check valve
- B. flap valve
- C. restrictor
- D. mixing chamber

78.-D

(Refer to page 141)

79. The boost pump fail light on the fuel management panel will illuminate when boost pump pressure falls below _____ psi.

79.-A (Refer to page 143)

- A. 16 - 17
- B. 18 - 20
- C. 20 - 21
- D. 21 - 22

80. Which of the following is NOT necessary to dump fuel?

80.-C (Refer to page 143)

- A. Boost pump
- B. Crossfeed valve
- C. Defueling valve
- D. Manual dump valve

FUEL LOW PRESSURE WARNING SYSTEM

The system consists of two pressure switches on the cabin ceiling and two LOW PR lights on the fuel management panel. The pressure switches will close when a negative pressure of -4.6 to -5.1 psi fuel pressure exists. This turns on the LOW PR lights and keeps them on until an increase of 2 psi occurs. At this time the pressure switches will open and cause the LOW PR lights to go out, indicating fuel pressure.

PRESSURE REFUELING SYSTEM

The system consists of a valve adapter, two precheck shutoff switches, four dual high level shutoff valves, four pressure fueling valves, and nine relief valves. (See figures 93 and 94.) When pressure refueling is desired, the pressure refueling cavity access cover is hinged down, and the valve adapter cover is removed. The refueling hose nozzle is properly grounded, inserted into the valve adapter, and fuel is pumped into the helicopter. At the beginning of refueling operations, the shutoff capability of the system is tested by pressing the high level shutoff switches to PRI TEST and SEC TEST independently. This energizes the appropriate solenoid of the high level valves. The solenoid raises the floats electrically, which closes the fueling valves and stops fuel flow into the tanks. When the switches are returned to the OFF position, the floats operate in conjunction with the fuel level of each tank. When the tanks reach full capacity, the high level shutoff valves close the fueling valves, stopping fuel flow to the tanks. Excessive fuel pressure is vented into the fuel tank by the relief valves.

NOTE

On Helos modified by T.C.F.O. 1H-3-568 and CG 1481 and subsequent: ensure fueling pressure does not exceed 50 psi. A pressure regulator and surge control valve is installed in the pressure refueling lines to prevent damage to the fuel system by faulty or improperly operated pressure refueling equipment.

VALVE ADAPTER

(See figure 93.)

The adapter is inside the hinged covered cavity below the personnel door and consists of a housing, poppet, spring, and cover. The poppet is unseated by the refueling hose nozzle, permitting fuel to enter the system. The spring returns the

poppet to its seat when the refueling nozzle is removed. The cover prevents contamination buildup on the poppet.

PRECHECK SHUTOFF SWITCHES

(See figure 93.)

The primary and secondary switches, marked PRI TEST and SEC TEST, are in the upper portion of the pressure refueling cavity. The switches, equipped with protective boots, are used to precheck the operation of the high level shutoff valves at the start of pressure refueling operations.

HIGH LEVEL SHUTOFF VALVES

(See figure 89.)

A high level shutoff valve is screwed to the top of each main fuel tank forward cell and the forward and aft auxiliary fuel tanks through the cabin floor. Each valve consists of a housing, primary and secondary solenoids, needle valves, and floats. At the beginning of pressure refueling operations, the PRI TEST and SEC TEST precheck switches are pressed independently. This actuates the appropriate solenoid, which electrically raises the floats to test shutoff capabilities of the valves. Fuel entering the tanks passes through the fueling valves and PRI and SEC ports of the valves. As the fuel level in the tanks increases, the floats rise, decreasing the needle valve opening. When the fuel reaches the predetermined full level, the floats close the needle valves, creating a pressure buildup in the fueling valve, stopping fuel flow to the tanks.

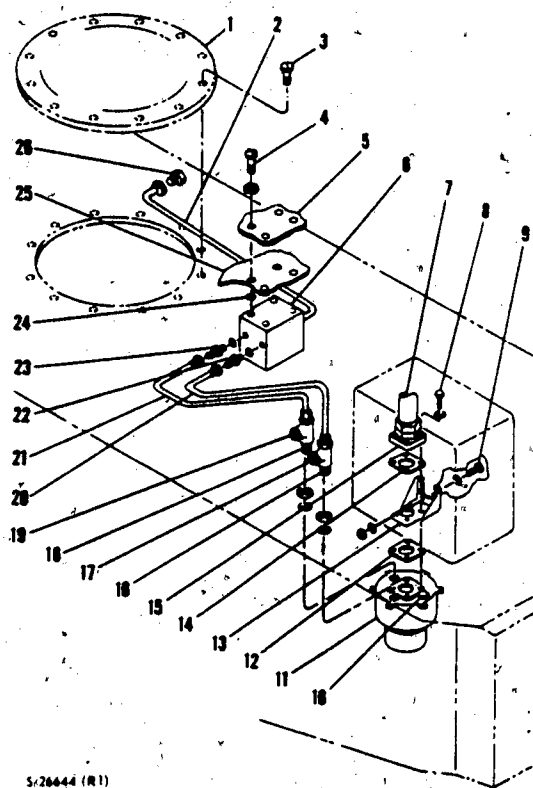
PRESSURE FUELING VALVES

(See figure 89.)

A pressure fueling valve is in each main fuel tank forward cell and in the forward portion of the forward and aft auxiliary fuel tanks. Each valve consists of a housing, poppet, diaphragms, and spring. During pressure refueling, the poppet unseats, permitting fuel flow to the tank and through the PRI and SEC ports to the high level shutoff valve. When the fuel tank reaches the pre-determined full level, the high level shutoff valve blocks the PRI and SEC fuel flow, creating a pressure buildup. This pressure buildup will cause the diaphragms to expand, closing the poppet and stopping fuel flow through the valve. The spring aids in closing the poppet when the diaphragms expand and keeps the poppet seated.

PRESSURE DEFUELING SYSTEM (LIMITED)

The system consists of the components of the pressure refueling system. When defueling is desired, connect a source of 28 volts DC power and engage the HI LEVEL SHUT-OFF circuit breaker. Hinge down the pressure refueling cover and remove the valve adapter cover. Position and properly ground the defueling nozzle and insert it into the valve adapter. Press the PRI TEST and SEC TEST high level shutoff switches together and apply suction force through the defueling hose, beginning the defueling process. Fuel will then be drawn from all tanks simultaneously until one of the four tanks is empty. The air ingested from the empty tank will cause the defueling operation from the remaining tanks to cease. The amount of fuel left in the various tanks will depend entirely on the initial quantities of fuel in each tank.



5/26644 (R1)

- | | |
|------------------------------|---------------------------|
| 1 Access Cover (Fuel Cell) | 13 Bracket |
| 2 Conduit (Electrical) | 14 Gasket |
| 3 Screws | 15 Connector |
| 4 Screws, Washers | 16 Tee, Nut, Packing |
| 5 Cabin Flooring | 17 Relief Valve (Packing) |
| 6 Valve (High Level Shutoff) | 18 Tee, Nut, Packing |
| 7 Tube | 19 Relief Valve (Packing) |
| 8 Bolt, Washers | 20 Tube |
| 9 Bolt, Washers, Nuts | 21 Tube |
| 10 Plug, Packing | 22 Union, Packing |
| 11 Valve (Fueling) | 23 Union, Packing |
| 12 Gasket | 24 Washer (Sealing) |
| | 25 Fuel Cell |
| | 26 Union |

Figure 89. - High level shutoff and fueling valves.

RELIEF VALVES (See figure 89.)

The valves, one in each tee on each fueling valve and in the pressure fueling tube in the aft main tank forward cell, prevent pressure surges from damaging fuel system components during pressure refueling. If pressure increases to 60 psi, the valves open, venting pressure into the fuel tanks until pressure drops to 55 psi.

INFLIGHT GRAVITY REFUELING SYSTEM

Aircraft modified by AR&SC Engineering Specification 13470.14 DO NOT have inflight gravity refueling connections.

FUEL TRANSFER SYSTEM (See figures 93 and 94.)

The system consists of two transfer switches on the fuel management panel, three transfer valves, three fuel ejector units, and three level control valves. The system, upon selection, transfers fuel from the forward and aft auxiliary tank to the forward main tank and from the aft auxiliary tank to the aft main tank. To transfer fuel from the forward auxiliary tank to the forward main tank, position the forward main

tank transfer switch to FWD AUX. To transfer fuel from the aft auxiliary tank to the forward main tank, position the forward main tank transfer switch to AFT AUX. To transfer fuel from the aft auxiliary tank to the aft main tank, position the aft main transfer switch to AFT AUX. When fuel transfer is desired, position the transfer switch to the desired AUX position. This opens the transfer valve, permitting fuel under boost pump pressure to enter the fuel ejector unit, starting fuel transfer to the main tank. As the fuel level in the main tank increases, the level control valve float rises with the fuel level. This decreases fuel flow into the main tank until the valve closes and stops fuel flow. As the fuel level in the main tank decreases, the level control valve opens, which starts fuel transfer. This will continue until auxiliary fuel is exhausted or the transfer switch is positioned to OFF.

FUEL TRANSFER VALVES (See figures 90 and 94.)

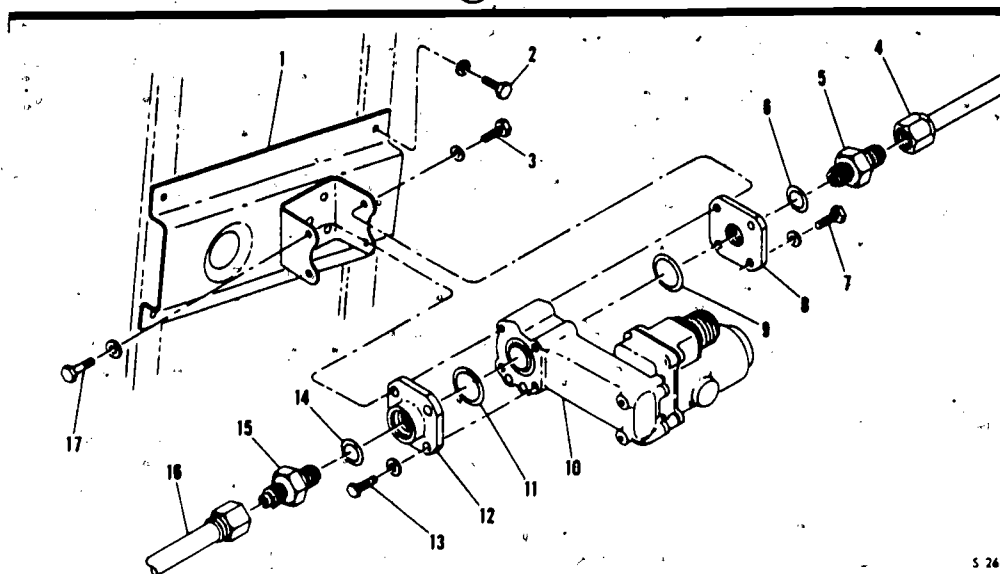
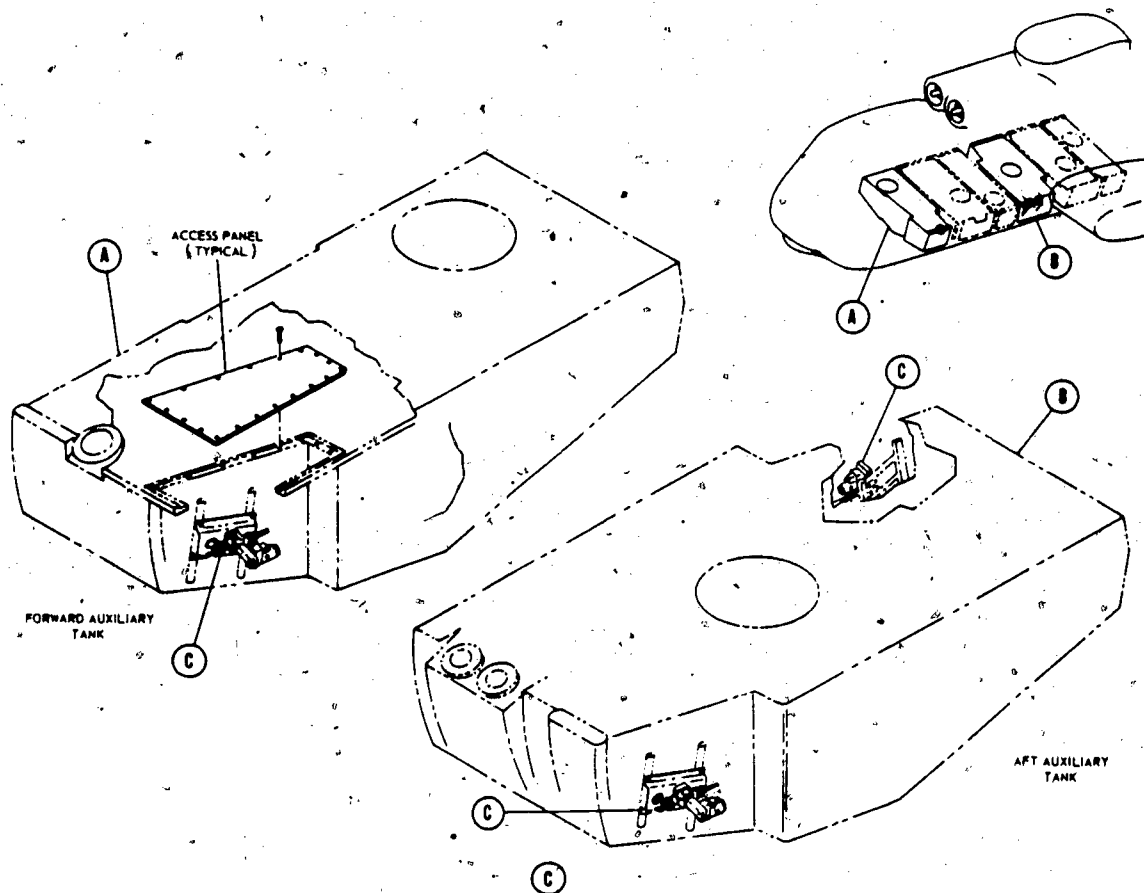
Each gate valve in the fuel lines between the boost pumps and fuel ejector units in the auxiliary fuel tanks consists of a motor, limit switches, and relief valves. When fuel transfer is desired, position the appropriate fuel transfer switch on the fuel management panel to the tank position. This actuates the motor to open the valve. When the valve is fully open, the motor actuates the limit switch, cutting electrical power to stop the motor. Simultaneously, the other limit switch is closed so the valve can be closed by positioning the transfer switches to OFF. When the valve opens, fuel from the appropriate boost pump reaches the fuel ejector units in the auxiliary fuel tanks, starting fuel transfer to the main fuel tanks.

LEVEL CONTROL VALVES (See figure 91.)

Three float-type valves, one in each main tank forward cell and forward main tank aft cell, stop fuel transfer from the auxiliary fuel tanks when the fuel level of the main tanks reaches a predetermined fuel level. The valve in the forward main tank forward cell controls fuel transfer from the forward auxiliary fuel tank, and the valve in the aft cell controls fuel transfer from the aft auxiliary fuel tank. The other valve in the forward cell of the aft main fuel tank controls fuel transfer from the aft auxiliary fuel tank.

FUEL EJECTOR UNITS (AUXILIARY TANKS) (See figure 92.)

Three fuel ejector units are bolted to supports, one in the forward auxiliary fuel tank and two in the aft auxiliary fuel tank. A line from the appropriate boost pump supplies fuel to the base of the units, passing fuel through a restricted throat. This increases fuel velocity while decreasing pressure, thus syphoning auxiliary tank fuel. The forward auxiliary tank unit transfers fuel to the forward main tank forward cell. The aft auxiliary tank units transfer fuel to the forward main tank aft cell and the aft main tank forward cell. A check valve is in each unit's inlet line to prevent air from entering the engine driven fuel pump if the boost pumps should fail and the fuel level should drop below the unit inlet.



S 26445 (R1)

Figure 90. - Fuel transfer valves.

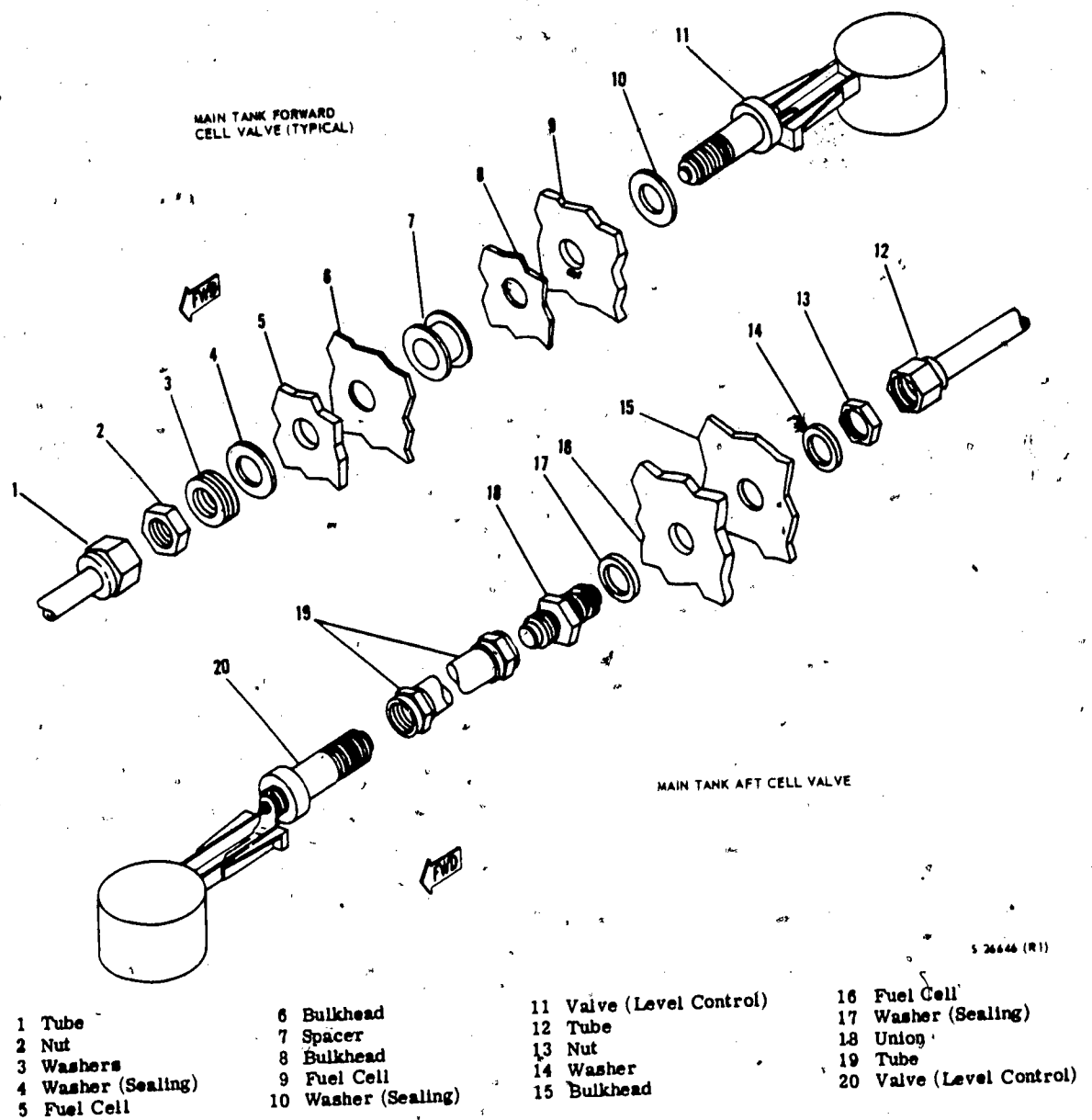
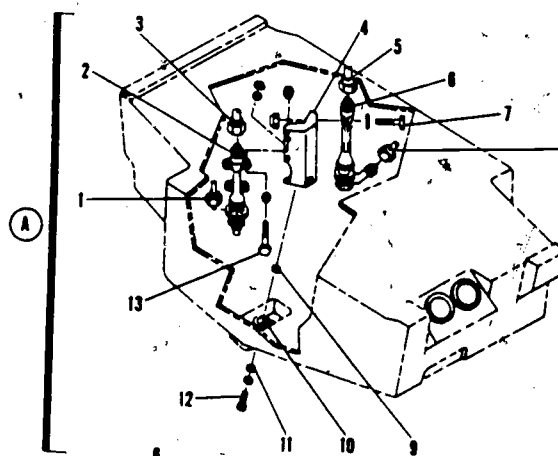
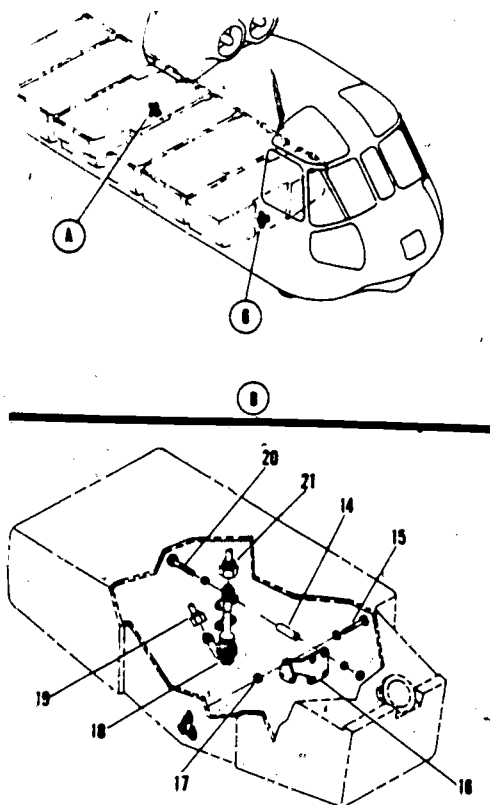


Figure 91. - Level control valves.

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5 26447 (R1)

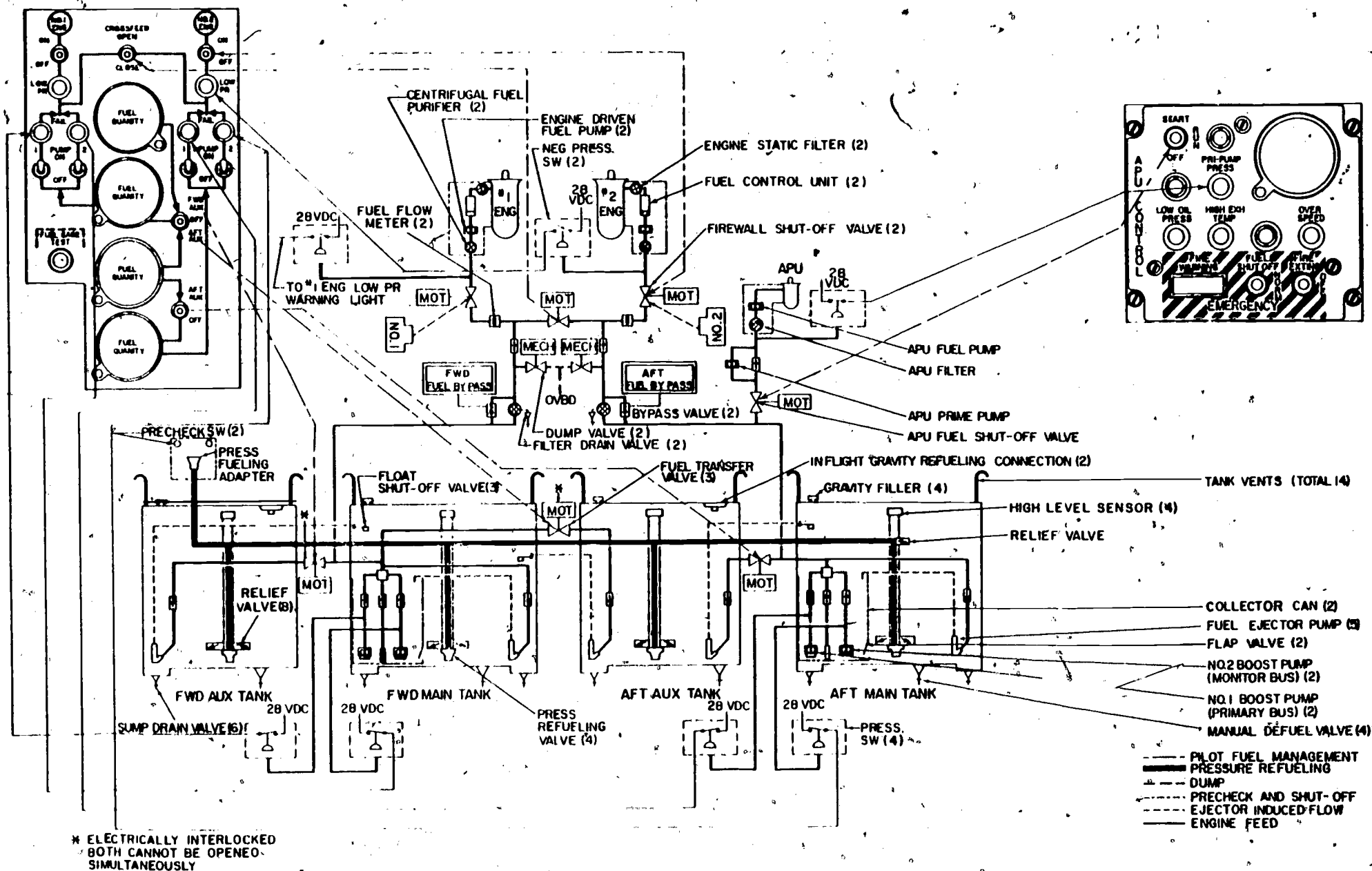
- 1 Tube
- 2 Fuel Ejector Unit
- 3 Tube
- 4 Support
- 5 Tube
- 6 Fuel Ejector Unit
- 7 Bolt, Washer, Nut

- 8 Tube
- 9 Washer (Sealing)
- 10 Sump Drain Valve
- 11 Washer (Sealing)
- 12 Bolt, Washers, Nut
- 13 Bolt, Washer, Nut
- 14 Spacer

- 15 Bolt, Washer
- 16 Support
- 17 Washer (Sealing)
- 18 Fuel Ejector Unit
- 19 Tube
- 20 Bolt, Washers, Nut
- 21 Tube

Figure 92. - Auxiliary fuel tanks fuel ejector units.

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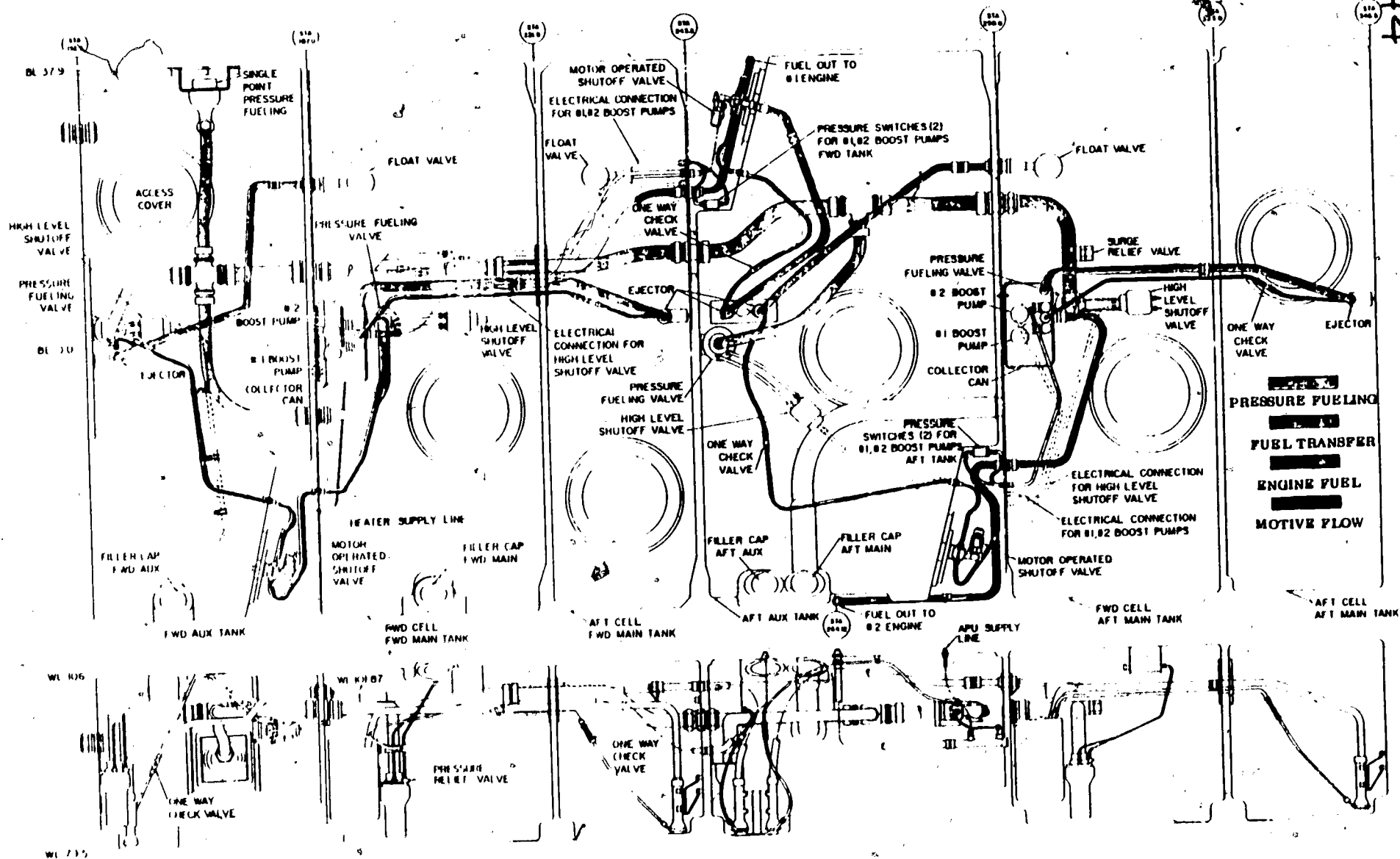


Figure 94. - Fuel system lower fuselage.

REVIEW

This material has been a continuation of the HH-3F fuel system and its components.

(Now answer the following review questions.)

81. Before pressure refueling the HH-3F, you must insure that the _____ will operate correctly. 81.-B (Refer to page 149)
- A. motor-operated shutoff valve
 - B. high level shutoff valve
 - C. float valve
 - D. boost pump
82. What terminates an HH-3F pressure de-fueling operation? 82.-A (Refer to page 150)
- A. A tank becoming empty
 - B. Low level warning actuation
 - C. The high level shutoff valve
 - D. Pressure fueling valve actuation
83. Which of the below are components of the fuel transfer system? 83.-A (Refer to page 150)
- 1. Fuel ejector units
 - 2. Level control valves
 - 3. High level shutoff valve
 - 4. Flapper valve
- A. 1 and 2 only
 - B. 1 and 3 only
 - C. 2 and 3 only
 - D. 1, 2, and 4
84. The aft auxiliary tank ejector units transfer fuel to the _____. 84.-A (Refer to page 151)
- A. forward main tank aft cell.
 - B. forward main tank forward cell.
 - C. aft main tank aft cell.
 - D. forward auxiliary tank aft cell.
85. What is the total number of fuel sump drain valves on the HH-3F? 85.-B (Refer to page 155)
- A. 4
 - B. 6
 - C. 8
 - D. 10

COMMUNICATION SYSTEMS

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the HH-3F ICS system and ICS system components.
2. Summarize the operation of the UHF communication system.
3. Identify the components of the HH-3F UHF system.
4. Explain the operation of the HH-3F VHF-FM/COMM radio system and identify its components.
5. Explain the operation of the HH-3F VHF/COMM radio system and identify its components.
6. Describe the HF/COMM radio system.
7. Explain the IFF transponder system and identify its components.

INTERCOMMUNICATION SYSTEM (ICS) AN/AIC-18

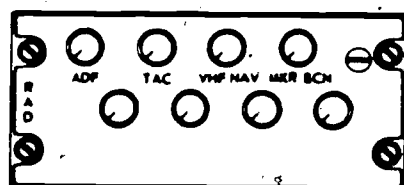
The AN/AIC-18 intercommunication system, ICS, provides communication between the various crewmembers. The ICS also links the audio channels of the communication and associated electronic equipment, to provide simplified control and simultaneous operation. The system is controlled through identical ICS control and monitor panels, provided for the pilot, copilot, and avionicsman (figures 95 and 97). In addition, the copilot has a remote ICS switch. The hoist station is equipped with a monitor panel, ICS station, and a hot mike switch (figure 99). The cabin aircrewman's station (jump seat) is equipped with an ICS station and a monitor panel (figure 96). The aft cabin station is equipped with an ICS station and a hot mike switch (figure 101).

The ICS circuits for the pilot, copilot, avionicsman, and crewmen are powered by the DC primary bus. The forward and aft exterior ICS receptacles are on the crewman's ICS circuit (figure 98). When the forward external ICS receptacle is in use, the jump seat ICS station is inoperative. When the aft external ICS receptacle is in use, the aft cabin ICS station is inoperative. The pilot's and avionicsman's ICS circuits are protected by circuit breakers on the pilot's circuit breaker panel. The circuit breakers are marked PILOT and NAV under the general headings DC, PRI, and

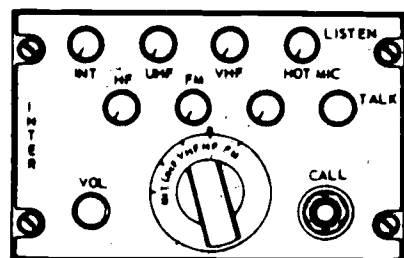
ICS. The copilot's and crewmen's ICS circuits are protected by circuit breakers on the copilot's circuit breaker panel. The circuit breakers are marked CO-PLT and CREW under the general headings DC, PRI, and ICS. (See tables 4 and 5).

ICS CONTROL

The ICS control, marked INTER, is a panel-mounted assembly on the pilot's, copilot's, and avionicsman's consoles. All switches and controls are front mounted except the external talk switch. Seven separate combination monitor selector/volume controls enable monitoring and individual listening level adjustment of the seven audio lines. The associated monitor switches are pulled out to monitor the desired audio lines. The level of the individual audio line is adjusted by rotating the associated monitor volume control. The six monitor selector/volume controls used are marked: INT, UHF, VHF, HOT MIC LISTEN, HF, and FM. A HOT MIC TALK switch is also on this panel. A rotary selector switch enables transmission and reception on ICS or selected radio communications systems. The switch is marked INT, UHF, VHF, HF, and FM. The external talk switches control operation of the selected transmitter. The ICS control panel also contains a VOL control to adjust the signal level to the associated headphones, a HOT MIC TALK on-off switch, and a CALL button for emergency call operation.



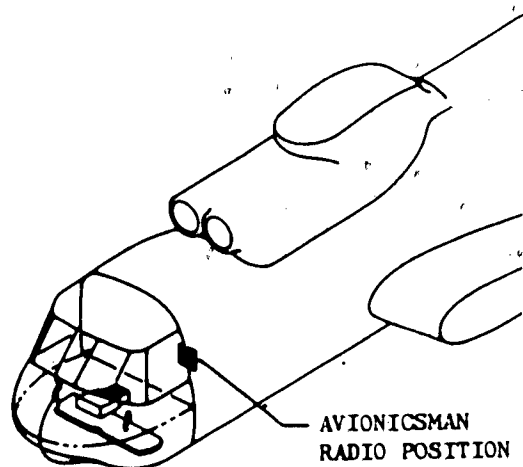
ICS MONITOR CONTROL



ICS CONTROL



JACK

AVIONICSMAN
RADIO POSITIONFigure 95. - ICS system avionicsman
AN/AIC-18.

The ICS controls provide four modes of microphone operation: one button, two button, HOT MIC, and CALL. The avionicsman has one-button operation which provides a capability to talk on the interphone line or a radio transmitter, as selected by the rotary selector switch. Two-button operation is a mode whereby the pilot and copilot may talk on the interphone line or a selected radio transmitter without the need for operating the selector switch on the ICS control panel. This capability is provided by rocker switches located on the pilot's and copilot's cyclic pitch stick. In addition, the copilot may talk on interphone or a selected radio by using the copilot's remote ICS switch. HOT MIC operation provides hand free intercommunication. CALL operation provides exalted intercommunication for high-priority or emergency messages. The call signal is heard at least six decibels louder than any other signal present.

ICS STATION

The ICS station is a bulkhead-mounted assembly with two controls mounted on the front panel. The VOLUME control adjusts the signal level to the headphones. The CALL button, which has a cap guard and chain, provides for emergency call operation on the interphone line. A plug connector and associated cable is used to connect the headset-microphone to the ICS station. The plug connector is a telephone jack with a push-to-talk switch and clip. (See figures 100 and 101).

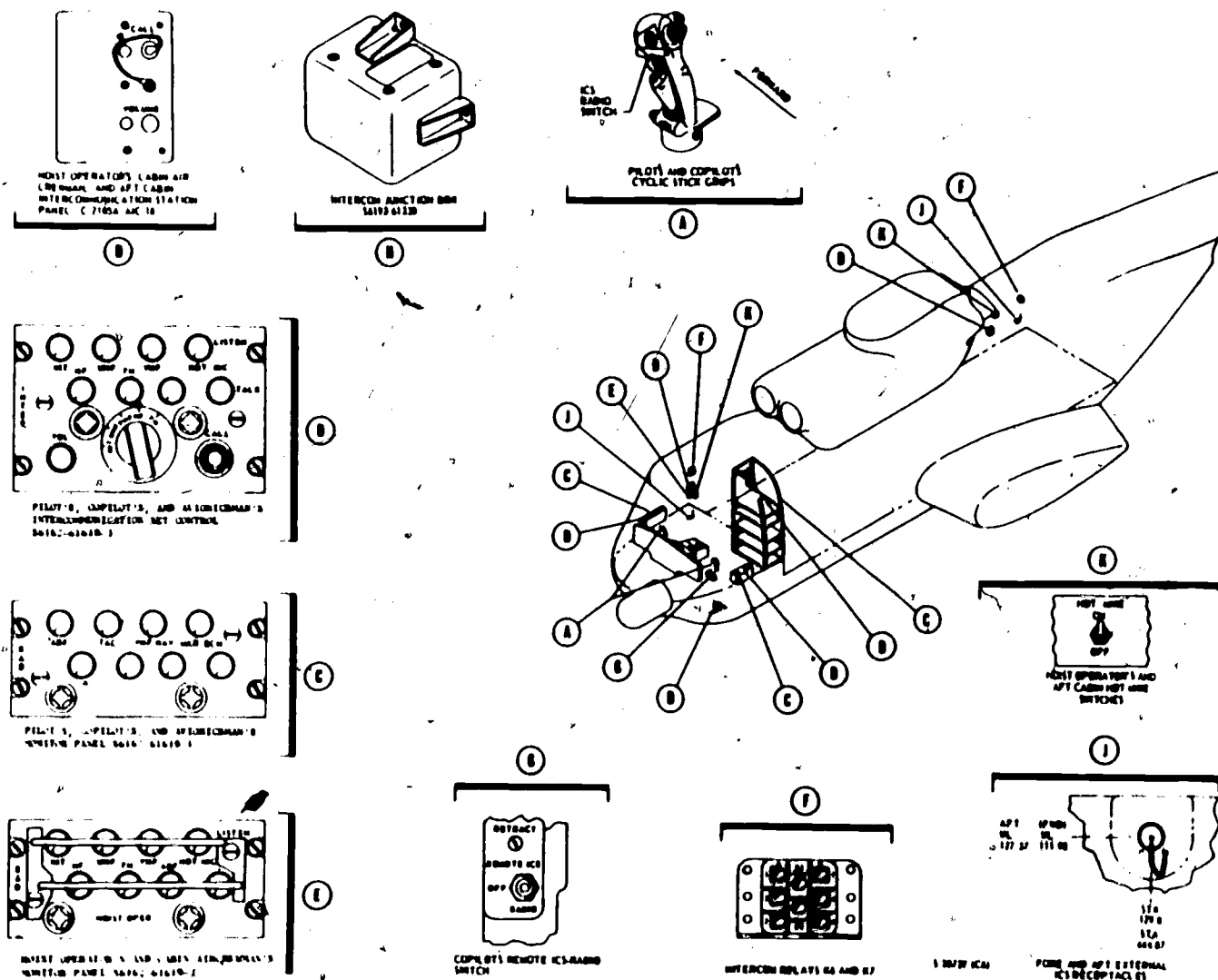
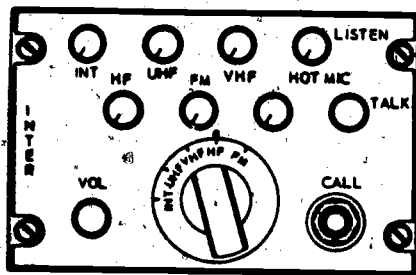


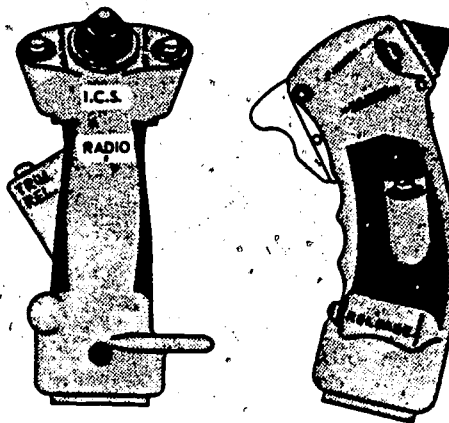
Figure 96. - INTERCOM system components - location diagram.



DETAIL A



DETAIL B



ICS ROCKER SWITCH, PILOT'S AND COPILOT'S
DETAIL C



ICS SWITCH PANEL, REMOTE, COPILOT'S
DETAIL D

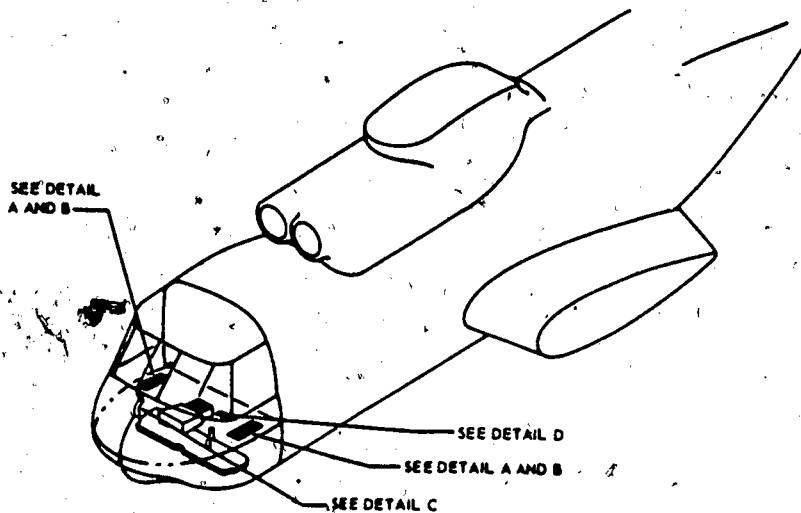


Figure 97. - ICS system pilot and copilot AN/AIC-18.

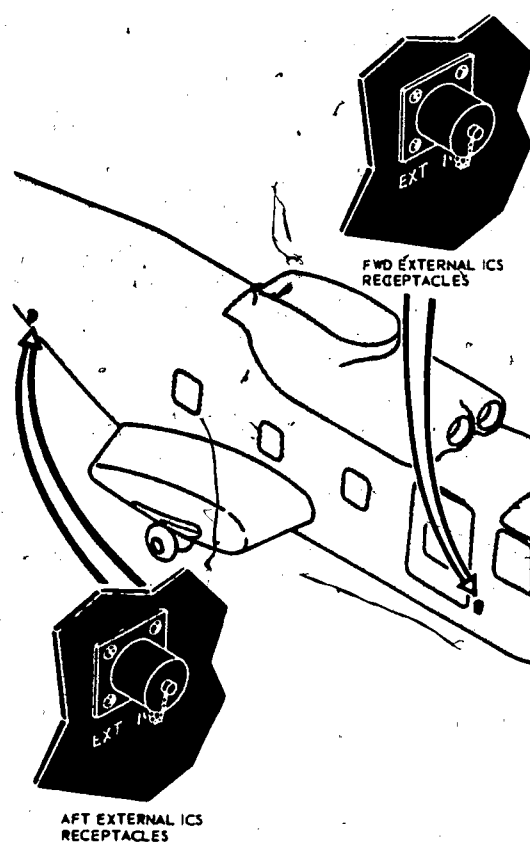


Figure 98. - ICS external stations AN/AIC-18.

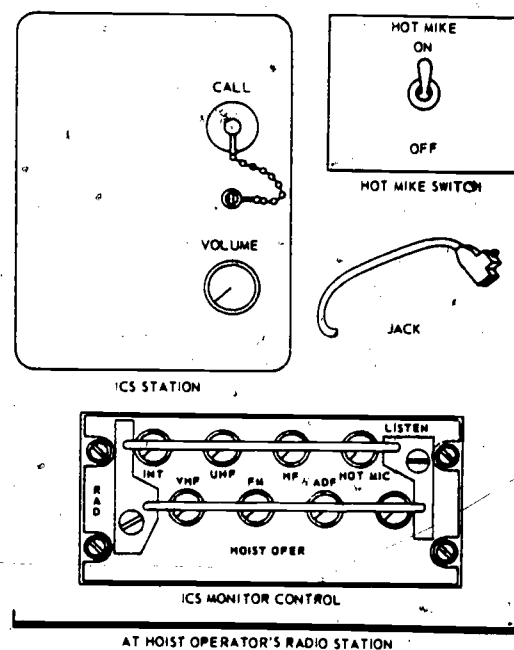


Figure 99. - ICS system hoist operator AN/AIC-18.

TABLE 4.

INTERCOM EQUIPMENT COMPONENTS - LEADING PARTICULARS

COMPONENT	FUNCTION
Intercommunication Set Controls	Provides selection of communications reception-transmission and intercommunication control to pilot, copilot, and avionicsman stations.
Intercommunication Station Panels	Provides intercommunications for hoist operator, cabin aircrewman, and aft cabin stations. Cabin aircrewman and aft cabin stations are electrically connected to fore-and-aft external ICS receptacles.

TABLE 4 (Cont.)

COMPONENT	FUNCTION
Monitor Panels	Provides additional monitoring circuits for pilot, copilot, avionicsman, cabin aircrewman, and hoist operator stations.
ASSOCIATED EQUIPMENT COMPONENTS	
INTERCOM Junction Box	Provides load for and distributes intercommunication, communication, and navigation audio input and output signals.
ICS-RADIO Switches	Allows pilot and copilot to key INTERCOM system or selected communication system. Provides ground path when pressed to ICS or RADIO.
Microphone Switch Cord Assembly	Allows avionicsman to key selected INTERCOM or communication systems. Allows crewman to key INTERCOM system.
Headset Microphone Copilot REMOTE ICS-RADIO Switch	Provides means of communication. When the switch is positioned to ICS, allows copilot hands-off INTERCOM key operation. Spring-loaded RADIO position returns to OFF when released.
External fore-and-aft ICS receptacles	Provides electrical connection to cabin air crewman and aft cabin stations for outside helicopter communications.
Relays K6 and K7	When de-energized, relays allow INTERCOM reception and transmission from aft cabin and cabin aircrewman stations. When energized, relays disconnect INTERCOM reception and transmission signal paths from, aft cabin and cabin aircrewman stations microphone switch cord assemblies, allowing INTERCOM reception and transmission through fore-and-aft external ICS receptacles.
Hot Mike Switches	Allows hoist operator and aft cabin stations to transmit on hot mike.
Junction Box (On helicopters which have received first airframe overhaul and CG 1480 and subsequent	Provides electrical connection for crewman's microphone switch cord assembly.

TABLE 5. STATION MODES OF OPERATION

STATION	NORMAL INTERCOM	CALL INTERCOM	HOT MIKE INTERCOM	COMM/NAV RECEPTION	COMM TRANSMISSION
Pilot	X	X	X	X	X
Copilot	X	X	X	X	X
Avionicsman	X	X	X	X	X
Hoist Operator	X	X	X	X	
Aft Cabin	X	X	X		
Cabin Air Crewman	X	X		X	

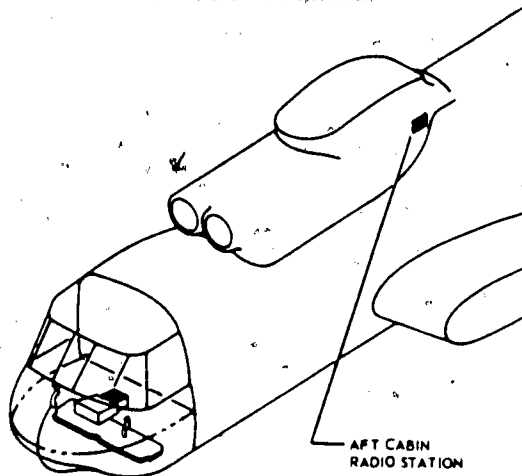
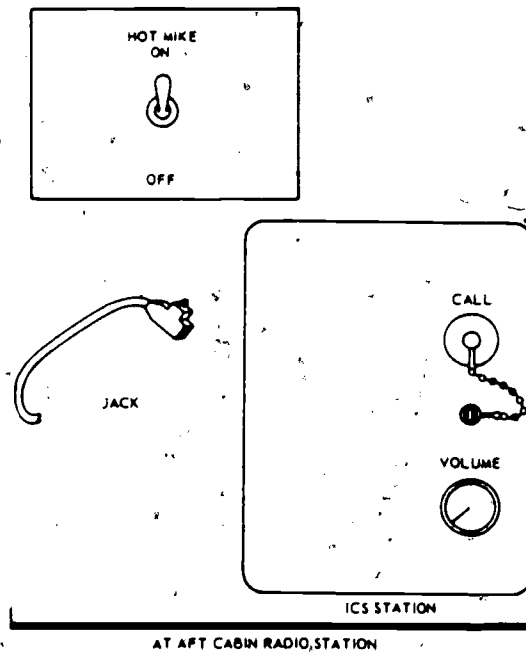


Figure 100. - ICS system aft cabin station AN/AIC-18.

ICS MONITOR CONTROL

The monitor panel, marked RAD, is a panel-mounted assembly with eight combination monitor selector/volume controls. At the pilot's, copilot's, and avionicsman consoles, only four are used, and they are marked ADF, TAC, VHF NAV, and MKR BCN. These monitor switch-volume controls permit monitoring of navigational systems which have output signals in the audio range. The hoist operator's and cabin aircrewman's stations are equipped with a monitor panel marked RAD and HOIST OPERATOR, and seven of the

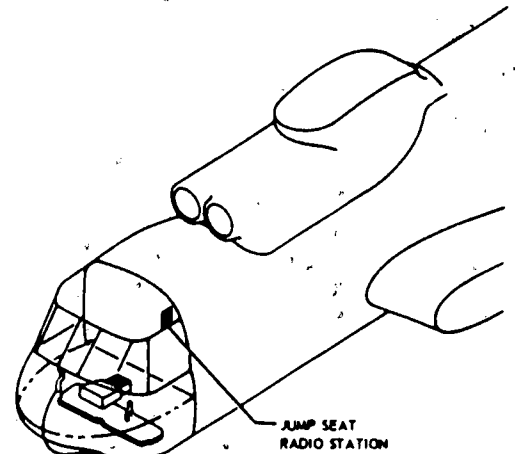
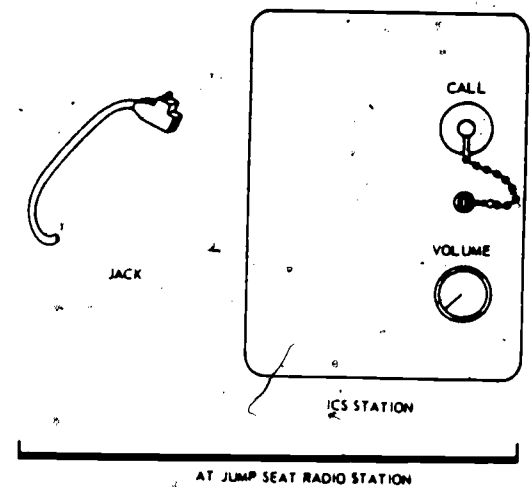


Figure 101. - ICS system jump seat AN/AIC-18.

eight monitor selector/volume controls are used. They are marked INT, UHF, HF, HOT MIC LISTEN, VHF, FM, and ADF. These controls permit monitoring and individual listening level adjustment.

HOT MIKE SWITCH

The hoist operator and aft cabin stations are equipped with a two-position HOT MIKE switch with the marked positions ON and OFF. These switches permit hands-free intercommunication. (See figure 99 and 100).

UHF/COMM RADIO SET AN/ARC-51A

The UHF/COMM system AN/ARC-51A is composed of a receiver-transmitter and a control panel. (See figure 103.) The set provides two-way voice communication between

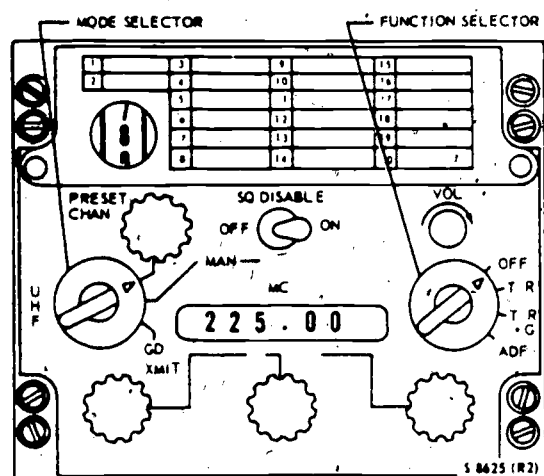


Figure 102. - UHF/COMM radio AN/ARC-51A.

land-based, seaborne or airborne stations. This can be accomplished on any one of 20 preset frequencies or by manually selecting any one of 3,500 channels spaced at 50 kHz intervals within the equipment's frequency range of 225.0 through 399.95 MHz. The radio set includes a guard receiver which permits continuous monitoring of the guard frequency at the same time the main transmitter receiver is tuned to a tactical frequency. In addition, the radio set provides automatic direction finding (ADF) in conjunction with the direction finding group DF-301. Magnetic bearing will be displayed by the No. 1 pointer on both RMI's.

The UHF/COMM system is equipped with two antennas. The antenna normally used is located above the cockpit, and the alternate antenna is located aft on the bottom of the pylon. The alternate antenna is used to eliminate UHF transmission and reception dead spots.

The AN/ARC-51A UHF radio set is powered from the No. 2 AC primary bus and the DC primary bus. The circuits are protected by circuit breakers on the pilot's circuit breaker panel. The AC circuit breaker is marked UHF, under the general heading NO. 2 AC PRI. The DC circuit breaker is marked UHF, under the general headings DC and PRI.

UHF/COMM CONTROL PANEL

The operating controls located on the AN/ARC-51A radio control panel (figure 102)

are the function selector, the mode selector, the preset channel control, the preset channel indicator, the frequency selectors, the frequency display window, the volume control, and the squelch disable switch.

Function Selector

The function selector has four positions. In the OFF position, all power is removed from the equipment. The T/R position energizes the receiver-transmitter, and the T/R + G energizes the receiver-transmitter and guard receiver. In the ADF position, the DF-301 is energized to provide automatic direction finding operation.

Mode Selector

The mode selector has three positions. The PRESET CHAN position permits selection of one of 20 preset channels by means of a preset channel control. In the MAN position, 3,500 frequency channels may be selected by using the manual frequency selectors. The GD XMIT position selects the preset guard frequency for the transmitter and receiver, with the function selector set at T/R. Setting the function selector to T/R + G, with the mode selector set at GD XMIT, turns the guard receiver on and places the transmitter, guard receiver, and main receiver on the guard frequency.

Preset Channel Control

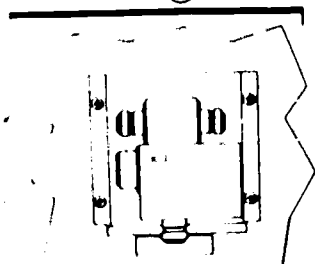
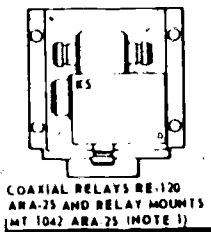
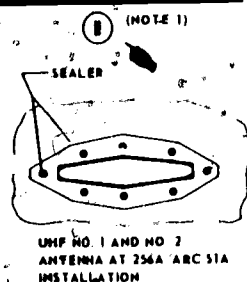
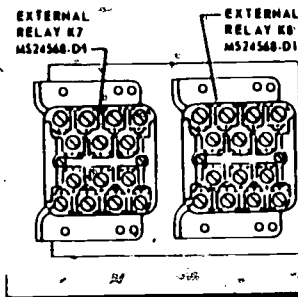
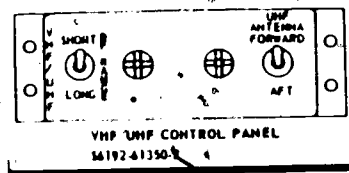
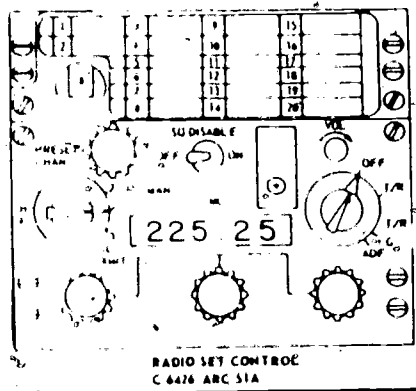
The preset channel control selects any one of the 20 preset channels. The preset channel indicator displays the preset channel.

Frequency Selectors

Frequency selectors provide manual frequency selection when the mode selector is set at MAN.

Vol Control

The VOL control adjusts the audio level of the receiver.



NOTES
1. ON HELICOPTERS MODIFIED BY
T.C.T.O. 1H-XHMF-551

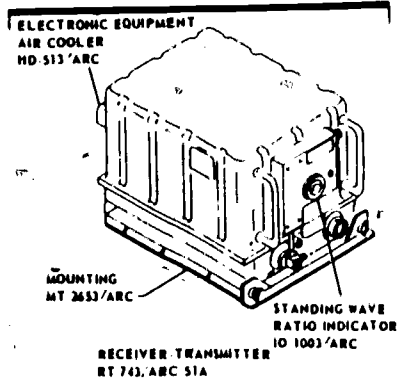
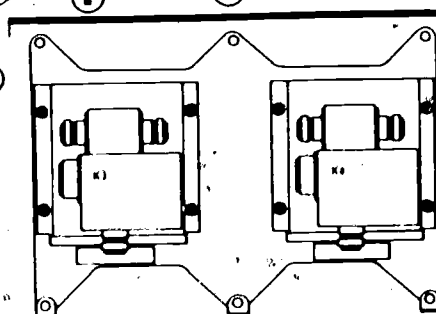


Figure 103. - UHF/COMM system components - location diagram.

SQ Disable Switch

The SQ DISABLE switch has two positions. In the ON position, the receiver squelch is disabled. In the OFF position, the receiver squelch circuit is unaffected.

Antenna Selector Switch

The antenna selector switch, marked FORWARD and AFT, is on the UHF ANTENNA switch panel (figure 104) located on the center console.

UHF/COMM OPERATION

To turn set on:

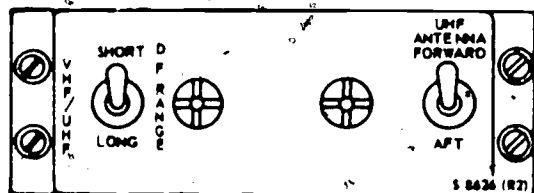


Figure 104. - UHF switch panel.

1. Function Switch (UHF/COMM Control Panel) AS REQUIRED.

2. Antenna Switch (UHF ANTENNA Switch Panel) - AS REQUIRED. (See figure 104).

3. ICS Monitor Selector/Volume Control - UHF.

4. ICS Transmit Selector Switch UHF.

5. Squelch Disable Switch - OFF.

6. Volume Control Knob (UHF/COMM Control Panel) - AS REQUIRED.

7. Mode Selector (UHF/COMM Control Panel) - AS REQUIRED.

8. Preset Channel Control (UHF/COMM Control Panel) - AS REQUIRED.

9. To transmit from the pilot's position - DEPRESS THE MICROPHONE TRIGGER SWITCH ON THE CYCLIC STICK GRIP TO THE RADIO POSITION, AND SPEAK INTO THE MICROPHONE.

10. To transmit from the copilot's position - DEPRESS THE MICROPHONE TRIGGER SWITCH ON THE CYCLIC STICK GRIP OR PLACE THE COPILOT'S REMOTE ICS SWITCH TO THE RADIO POSITION AND SPEAK INTO THE MICROPHONE.

To secure set:

1. Function Switch (UHF/COMM Control Panel) - OFF.

REVIEW

This section has covered the ICS and UHF communications systems on the HH-3F. You need to be familiar with these systems to be a flight mechanic on the HH-3F.

(Now answer the following review questions.)

86. The HH-3F has a total of _____ ICS stations.

86.-C (Refer to page 161)

- A. 2
- B. 4
- C. 6
- D. 8

87. Two-button operation is a mode of microphone operation provided by the ICS controls. By selecting this mode, the pilot has _____.

87.-B (Refer to page 162)

- A. the capability to talk on the interphone line as selected by the rotary selector switch
- B. the capability to talk on the interphone line without operating the selector switch on the ICS control panel
- C. free-hand intercommunications
- D. exalted intercommunication for high-priority messages

88. Which ICS stations are equipped with a two-position HOT MIKE toggle switch?

88.-B (Refer to page 167)

- 1. Pilot
- 2. Copilot
- 3. Avionicsman
- 4. Hoist operator
- 5. Aft cabin

- A. 1 and 3 only
- B. 4 and 5 only
- C. 1, 2, and 4 only
- D. 1, 2, 4, and 5 only

89. The antenna normally used for the UHF/COMM system is located _____.

89.-A This antenna is ahead of the FOD shield. (Refer to page 168)

- A. above the cockpit
- B. on the right-hand side of the fuselage
- C. aft on top of the pylon
- D. aft on the bottom of the pylon

90. The AN/ARC-51A UHF radio set gets its power from _____.

90.-D (Refer to page 168)

- A. 28V DC and No. 2 AC radio bus
- B. 26V DC and No. 1 AC radio bus
- C. No. 1 AC primary bus and DC primary bus
- D. No. 2 AC primary bus and DC primary bus

91. The UHF antenna selector switch is located on the _____.

91.-C (Refer to page 170)

- A. instrument panel
- B. overhead switch panel
- C. center console
- D. radio control panel

VHF-FM/COMM RADIO SET RT-9600

The VHF-FM COMM system RT-9600 is composed of a receiver-transmitter and a control panel. The set provides two-way voice communications between land-based, seaborne, or airborne stations. This may be accomplished on any one of 9,600 manually selected channels spaced at 2.5 kHz increments in the 150.0000 to 173.9975 MHz frequency range. The radio set includes a two channel guard receiver with priority interrupt function. These guard channels can be set to any frequency in the 150.0000 to 173.9975 MHz range. The international VHF-FM guard frequency is 156.800 MHz. The set is used in conjunction with the DF-301 Homer.

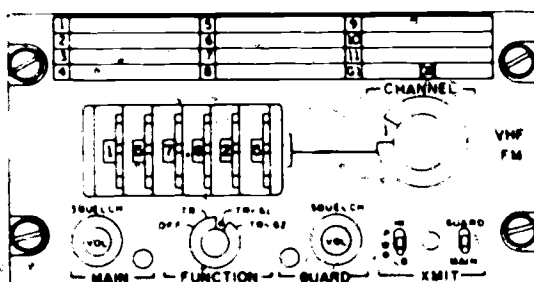


Figure 105. - VHF-FM/COMM Control Unit

VHF-FM/COMM Control Unit (Fig. 105)

The C-961 VHF-FM control unit, located on the center console, is marked VHF-FM. The control unit contains frequency select switches, preset channel selector, function select switch, hi-lo power switch, transmit select switch, and volume and squelch controls.

Frequency Select Switches

Six thumb wheel frequency selector switches provide for the manual selection of 9,600 channels from 150.00 to 173.9975 MHz in 2.5 kHz steps. The frequency selected is indicated directly on the switches. The manual mode is selected by aligning the preset select switch with the line connecting the two sets of switches.

NOTE

Do not change the frequency indicator selector switch settings while keying the transmitter, as damage to the radio set may occur.

Preset Channel Select Switch

The preset channel select switch provides for the selection of any one of the 11 preset channels, as listed on the face of the control unit.

Function Select Switch

The function select switch has four positions: OFF, TR, TR+G1, and TR+G2. In the OFF position, power is removed from the set. The TR position energizes the receiver-transmitter to the manually selected or preset frequency. The TR+G1 or +G2 position energizes the main receiver-transmitter and the guard receiver. The frequency of the guard receiver is preprogrammed and is selected by the switch position.

High-low Power Switch

A high-low power toggle switch selects the transmitters power output, 1 watt for LO and 10 watts for HI.

Transmit Frequency Select Switch

The transmit frequency select toggle switch is used to select the transmitter frequency. In the MAIN position, the transmitter frequency will be that selected by the frequency select switches. In the GUARD position, the frequency will be either the preset G1 or G2 frequency.

Squelch and Volume Controls

There are two set of squelch and volume controls: main receiver and guard receiver. The volume control adjusts the receiver's audio listening level. The squelch control adjusts to eliminate receiver background noise. Beside each control is a squelch lamp. The lamps indicate when there is a signal on the main receiver or guard receiver.

VHF-FM/COMM OPERATION

To turn set ON:

1. Function selector switch (VHF-FM/COMM control panel) - AS REQUIRED.
2. ICS receiver select switch --FM - ON.

3. ICS transmit select switch - FM.
4. Frequency Selector switches (VHF - FM/COMM control panel) - AS REQUIRED.
5. HI-LOW PWR. switch (VHF-FM/COMM control panel) - AS REQUIRED.
6. VOL control knob (VHF-FM/COMM control panel) - AS DESIRED.
7. Squelch control knob (VHF-FM/COMM control panel) - AS REQUIRED.

VHF/COMM RADIO SET AN/ARC-84

The VHF/COMM system AN/ARC-84 is composed of a receiver, a transmitter, and a control panel. (See figure 106.) The set provides two-way voice communication between land-based, seaborne and airborne stations. The transmitter and receiver are designed to operate on crystal controlled channels spaced 50 kHz apart. The range of the transmitter is 118.0 through 135.95 MHz., and the range of the receiver is 108.0 through 135.95 MHz. In addition, the receiver is designed to operate in conjunction with the DF-301 direction finder group to allow VHF/ADF homing. Magnetic bearing will be displayed by the No. 1 pointer of both RMI's. The VHF receiver and transmitter are powered by the DC primary bus. The receiver and transmitter are protected by circuit breakers on the pilot's circuit breaker panel. The circuit breakers are marked RCVR and XMTR under the general headings DC, PRI, and VHF.

VHF/COMM CONTROL PANEL

The operating controls are provided by a control panel (figure 107) marked COMM, located on the cockpit center console. The panel consists of two frequency selectors, the frequency display window, the off-on/volume control, a squelch control, a momentary VHF-ADF homing select switch, a VOR momentary check switch, and a mode selector switch.

Frequency Selectors

The frequency selectors mechanically select and display frequencies spaced 50 kHz apart over the 108.00 through 135.95 MHz range.

VOL OFF Switch

The VOL OFF switch provides power control to the radio and volume control of the audio level.

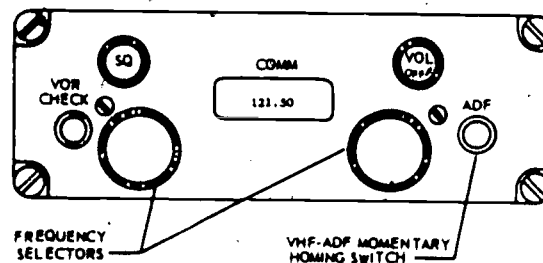


Figure 107. - VHF/COMM radio AN/ARC-84.

SQ Control

The SQ control eliminates background noise.

ADF Switch

The momentary ADF homing select switch displays magnetic bearing with the No. 1 pointer of each RMI, as long as the switch is held down.

VOR Check Switch

The VOR momentary check switch is inoperative on the VHF/COMM control panel.

VHF/COMM OPERATION

To turn set on:

1. VOL OFF Switch (VHF/COMM Selector Panel) - ON.
2. ICS Monitor Selector/Volume Control - VHF.
3. ICS Transmit Select Switch - VHF.
4. Frequency Selectors (VHF/COMM Control Panel) - AS REQUIRED.
5. SQ Control (VHF/COMM Control Panel) - AS REQUIRED.
6. To transmit - DEPRESS THE MICROPHONE TRIGGER SWITCH ON THE CYCLIC STICK GRIP TO THE RADIO POSITION, AND SPEAK INTO THE MICROPHONE.

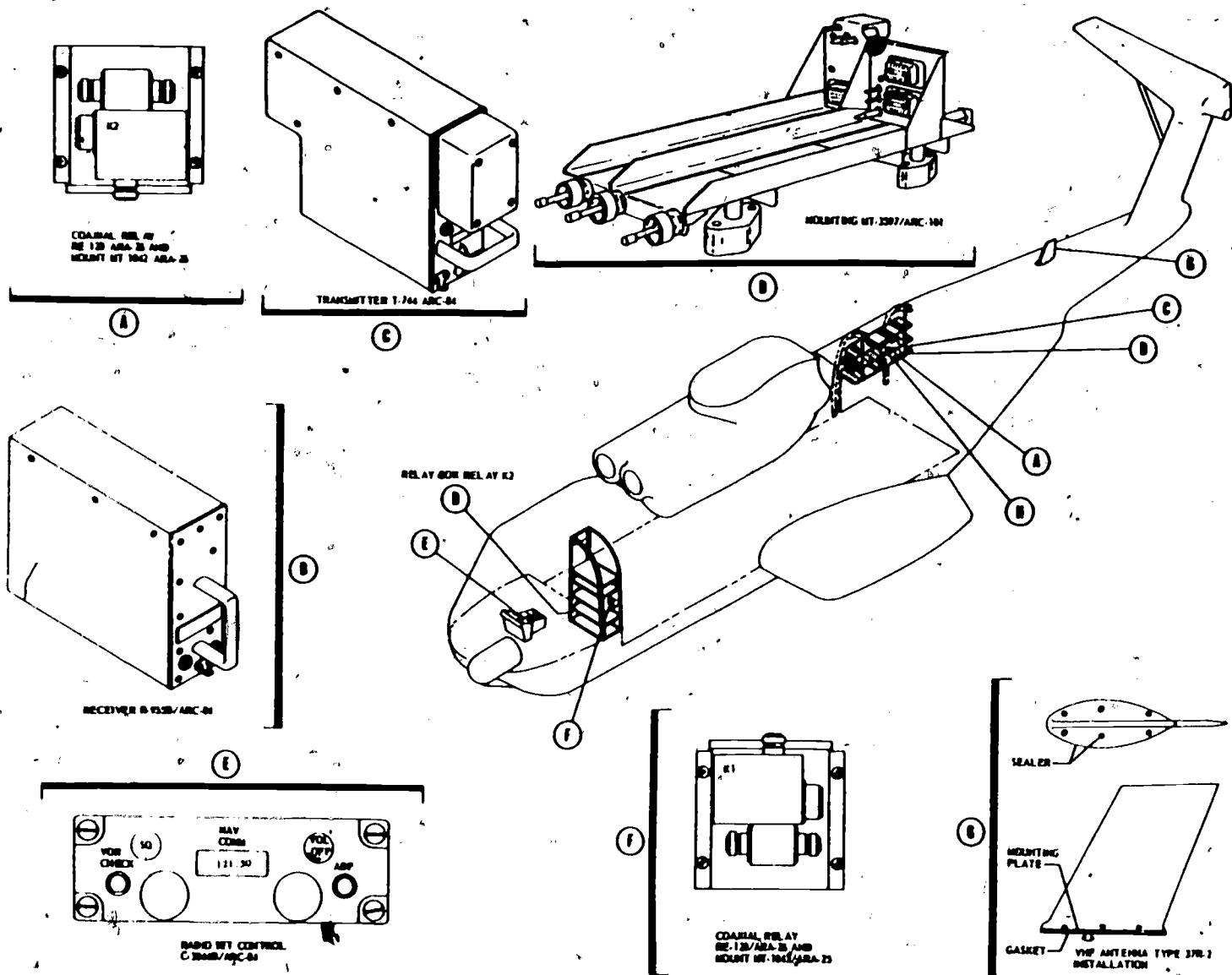


Figure 106. - VHF/COMM system components - location diagram.

To secure set:

1. VOL OFF Switch (VHF/COMM Control Panel) - OFF.

HF/COMM RADIO SET AN/ARC-94

The HF/COMM system AN/ARC-94 consists of a receiver-transmitter, two control panels, an antenna, a coupler, and a coupler blower. (See figure 108). The system provides a two-way voice communication between land-based, seaborne, and airborne stations. The operating frequency range is from 2.0 to 29.999 MHz, divided into 28,000 discrete channels in one kHz increments. The HF/COMM system receives and transmits on either single sideband (USB or LSB) or amplitude modulated equivalent (AM). The receiver transmitter and the coupler blower are both powered by the No. 2 AC primary bus. The radio set uses 400-Hz three-phase 115-volt AC, and the coupler blower uses 400-Hz single-phase 115-volt AC power. Each unit is protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is under the general heading NO. 2 AC PRI. The receiver and transmitter circuit breaker is marked HF, and the coupler blower circuit breaker is marked HF COUPLER BLOW. The control circuit illuminates the avionicsman's HF control light (figure 111) and is powered by the DC primary bus. This circuit is protected by a circuit breaker on the pilot's circuit breaker panel. The circuit breaker is under the general heading DC PRI and is marked HF.

HF/COMM OPERATING CONTROLS

The system is remotely controlled by either one of two control panels (figure 109) marked HF. One control panel is located on the copilot's console and the other on the avionicsman's console. In addition, the copilot's console contains an HF/COMM switch panel (figure 110) with marked positions RADIO NAV and COPILOT. This switch permits the copilot to transfer control to or remove control from the avionicsman's control panel. The COPILOT position gives control of the set to the copilot, and the RADIO NAV position gives control of the set to the avionicsman. An advisory light (figure 111), marked HF CTR, is illuminated on the avionicsman's console above the HF/COMM control panel when the avionicsman has control. Both HF control panels contain a mode selector, four frequency selector knobs and associated display window, and a volume control knob.

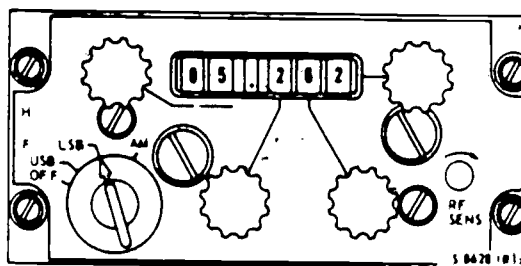


Figure 109. - HF/COMM radio AN/ARC-94.



Figure 110. - HF/COMM switch panel.

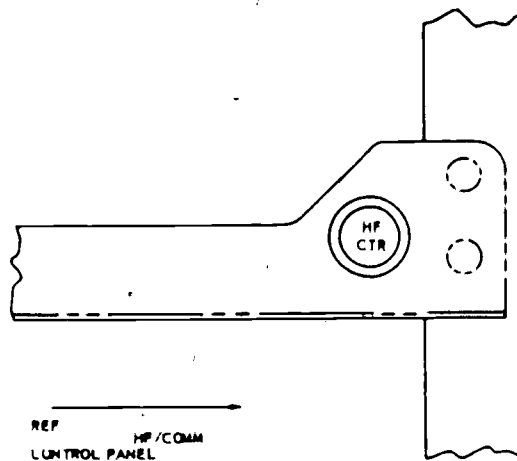


Figure 111. - HF/COMM control advisory light.

Mode Selector

The mode selector has four marked positions: OFF, USB, LSB, and AM. The OFF position removes aircraft power from the set. The USB position selects upper sideband operation, and the LSB position selects lower sideband operation. The AM position provides amplitude modulation operation of the radio.

Frequency Control

The control panels each have a frequency display window that reads in megahertz and four frequency selector knobs to select operating frequencies. (See figure 109.)

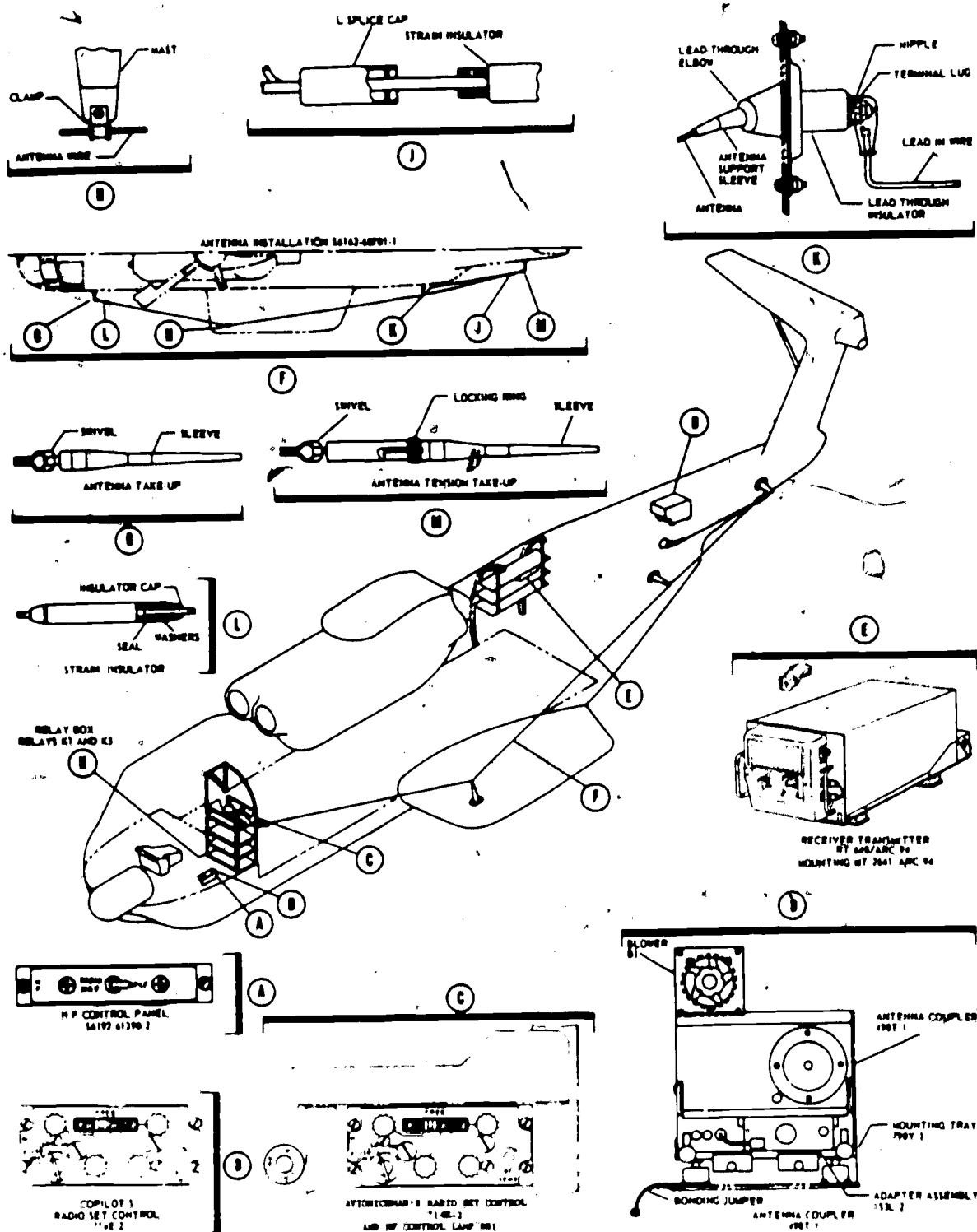


Figure 108. - HF/COMM system components - location diagram.

Volume Control

A volume control knob marked RF SENS adjusts the receiver sensitivity of the receiver-transmitter.

WARNING

During ground operation of the AN/ARC-94, ensure that personnel are clear of the antenna. Serious burns may result if bodily contact is made with the antenna during ground operation.

WARNING

Do not transmit in 3.0 and 3.6 MHz range during Doppler or coupler hover operation. Transmission in this range will result in erratic aircraft attitude.

HF/COMM RADIO SET AN/ARC-94 OPERATION

To put the equipment into operation:

1. HF/COMM Control Selector Switch (HF/COMM Switch Panel) - AS REQUIRED. (See figure 110.)
2. Mode Selector (HF/COMM Control Panel) - AS REQUIRED.
3. ICS Monitor Selector/Volume Control - HF.
4. ICS Transmit Selector Switch - HF.
5. Frequency Selector (HF/COMM Control Panel) - AS REQUIRED.

NOTE

While set is channeling, no background noise will be heard in the headset. The channeling cycle is complete when background noise is heard.

6. Microphone Switch - DEPRESS MOMENTARILY.

NOTE

When microphone switch is depressed, a one kHz tone will be heard in the headset. When the tone disappears, antenna loading is complete and the set is ready for operation.

7. To transmit - DEPRESS MICROPHONE SWITCH.

To secure equipment:

1. Function Selector Switch (HF/COMM Control Panel) - OFF.

AIMS/IFF TRANSPONDER AN/APX-72

The AN/APX-72 AIMS/IFF transponder is composed of a receiver-transmitter, a transponder set control, a transponder inflight test set, an altimeter encoder (on helicopters modified by TO 1H-3(H)F-567, and an antenna. The transponder provides IFF identification in response to coded interrogations from ground, seaborne, or airborne stations. In addition, the signals returned from the IFF transponder can be used by the interrogating station to determine range and azimuth information. The IFF transponder is powered by the DC primary bus and the NO. 2 AC primary bus. These circuits are protected by circuit breakers on the pilot's circuit breaker panel. There are two DC circuit breakers, marked PWR and TEST under the general headings DC, PRI, and IFF. The AC circuit breaker is marked IFF PA under the general heading NO. 2 AC PRI.

AIMS/IFF TRANSPONDER CONTROL PANEL

The transponder control panel, marked IFF, is located on the cockpit console.

Master Switch

The MASTER switch selects five conditions of operation: OFF, STBY, LOW, NORM, and EMER. In OFF, power is not applied to the set components. In STBY (standby), power is applied to components, the transponder is warmed up ready to respond, but not signals will be transmitted. In LOW, receiver sensitivity is reduced by a preset amount such that only higher energy signals will trigger the transponder. In NORM, the transponder will operate at normal sensitivity and respond to interrogations in accordance with settings of other controls. In EMER (emergency), emergency signal responses will be transmitted in modes 1, 2, or 3/A regardless of the settings of the mode control toggle switches. A detent prevents accidental selection of the EMER position. To bypass the detent, raise the center cap on the switch.

Mode Enable Toggle Switches

Four toggle switches, marked M-1, M-2, M-3/A, and M-C, have three marked positions OUT, ON, and TEST. The OUT (down) position prevents responses in each mode. The ON (center) position permits responses in each mode. The TEST (up) position will illuminate the TEST light, in the upper section of the control box, if the transponder is replying.

NOTE

On helicopters modified by T.O. 1H-3(H)F-567, Mode C, when ON, operates in conjunction with the pilot's AAU-21/A or AAU-32/A pressure altimeter-encoder to automatically provide encoded pressure altitude information from the helicopter to interrogating ground stations with Mode C decoding capability. Mode C operates independently of the other modes selected.

REVIEW

You have just completed a discussion of the VHF-FM/communication system, VHF/communication radio set, HF/communication radio set, and IFF transponder system. This information will help you become a qualified aircrewman on the HH-3F.

(Now answer the following review questions.)

92. The VHF-FM Guard Frequency is _____ MHz. 92.-A (Refer to page 173)
- A. 156.800
B. 156.900
C. 158.800
D. 159.800
93. The Main Receiver Squelch Lamp on the C-961 VHF-FM Control Unit is illuminated when _____ 93.-A (Refer to page 173)
- A. The RT-9600 is transmitting
B. The Receiver Squelch Circuit fails
C. The Main Receiver receives a signal
D. It is not safe to transmit
94. The range of the AN/ARC-84 receiver is _____ MHz. 94.-A The channels are spaced 50 kHz apart. (Refer to page 174)
- A. 108.0 - 135.95
B. 108.0 - 139.55
C. 118.0 - 135.95
D. 118.0 - 139.95
95. Which operative controls does the VHF/COMM control panel contain? 95.-A (Refer to page 174)
1. Frequency display window
2. Two frequency selectors
3. Half duplex switch
4. VOR momentary check switch
- A. 1 and 2 only
B. 3 and 4 only
C. 2, 3, and 4 only
D. 1, 2, 3, and 4
96. Which of the below is NOT a position on the HF/COMM mode selector? 96.-D The HF mode selector has four positions. (Refer to page 176)
- A. OFF
B. USB
C. LSB
D. ON

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97. When the frequency selector on the AN/ARC-94 control is shifted to a new frequency, the equipment is ready for two-way communications when _____.

- A. a frequency is selected
- B. the tone stops
- C. the channeling cycle is complete
- D. a background noise is heard

98. The IFF transponder is capable of transmitting emergency signal responses in which mode(s)?

- A. 1 only
- B. 2 only
- C. 3/A only
- D. All of the above.

97.-D

When the tone disappears, the antenna is loaded and the set is ready for use. (Refer to page 178)

98.-D

(Refer to page 179)

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NOTICE TO STUDENTS

ENROLLED IN

ACH52-3

(Course Code 0441-3)

Pamphlet 656 -- Dated 04/81: Make the following corrections:

Page 3-4: Replace paragraph with the following:

TOWING OF THE HELICOPTER ON WATER

When a helicopter is disabled on the water, a decision must be made about the recovery method. Towing has proven to be a very successful method provided the conditions are correct. The conditions are calm seas with swells not to exceed 2 feet, towing during daylight hours only, all windows and door installed and closed, and flotation bags installed and properly inflated. The helicopter may be towed either tail or nose first. The preferred method is tail first because of the possible reduced damage to the main rotor blades. The tow line is attached to the tail tie-down ring for tail-first towing and to the bow eye on the nose fitting for bow-first towing. To minimize surging and provide the best stability, a tow line length of 100 feet is recommended. For added stability, a trippable sea drogue may be attached to the opposite end of the aircraft from the tow line connection. Be extremely careful during the entire operation to prevent damage to the helicopter. Any boat that comes alongside the aircraft should approach from the windward side because the helicopter will drift downwind more rapidly than the boat. Whenever possible, tow the aircraft into the wind and always try to avoid heading parallel to the wave troughs. The towing speed will be determined by the conditions but must not exceed 4 kts.

Inverted towing and salvage operations are covered in Chapter 15 of CGTO 1H-52A-2.

Page 3-5: Portable Fire Extinguisher. Correct 2nd sentence to read:

A second CO₂ fire extinguisher is located in the cabin and is mounted to the aft cabin bulkhead below the cabin/transition access door.

Page 3-14: Correct to read as follows:

10. The recommended attachment point(s) for the tow line is/are the _____

- A. main mount tie-down rings
- B. high tie-down rings
- C. towing eye on tail wheel
- D. tail tie-down ring or bow eye

17. response B. Change 5 to 4.

Page 3-15: Question 26. Correct response C to read:

C. Behind pilot's seat and below transition compartment access door

Pamphlet 655 -- Make the following corrections:

Page 8-4: Replace Figure 8-3 with attached figure.

Page 8-6: Emergency Exit Lights. Change 4th sentence to read as follows:

The system is operated by a switch, marked ARM-OFF-DISARM, located on the copilot's instrument panel adjacent to the caution/advisory light panel and above the Radar Altimeter.

Page 10-1: Interphone Control Panel. Second sentence. Change forward to aft.

Page 10-5: VHF/COMM Control Panel. Correct 1st sentence to read:

The VHF control panel, marked COMM, is located on the right side of the upper radio console (figure 10-20).

Page 10-15: GVR (G) MODE. Correct the paragraph as follows:

When the indicator is in the GVR mode, the information displayed depends on the position of the GVR/LORAN selector switch located in the upper left of the pilot's instrument panel. In GVR,....In the LORAN position, Loran C information is supplied to the vertical bar. The bar position indicates direction off course to the way point selected by the Loran computer.

Page 10-18: LF-ADF Control Unit. 1st sentence. Change left to right.

Page 10-21: Transponder Control Panel -- 1st sentence. Change at to near.

Page 10-23: Add new subject:

LORAN-C NAVIGATIONAL SYSTEM AN/ARN-133

The Loran-C navigational system is a microcomputerized navigator providing continuous navigation and steering information to select waypoints. The

systems consists primarily of the navigator unit, remote display unit, GVR/LORAN selector switch, and the flight director.

Loran-C Navigator Unit (Figure 10-20)

The navigator unit is located in the left side of the lower radio console. The unit is a self-contained receiver and navigation computer. The Loran-C processes Loran signals, computes, and displays all navigational data selectable. Steering signals are sent to the flight director indicators to provide steering control to the selected waypoint.

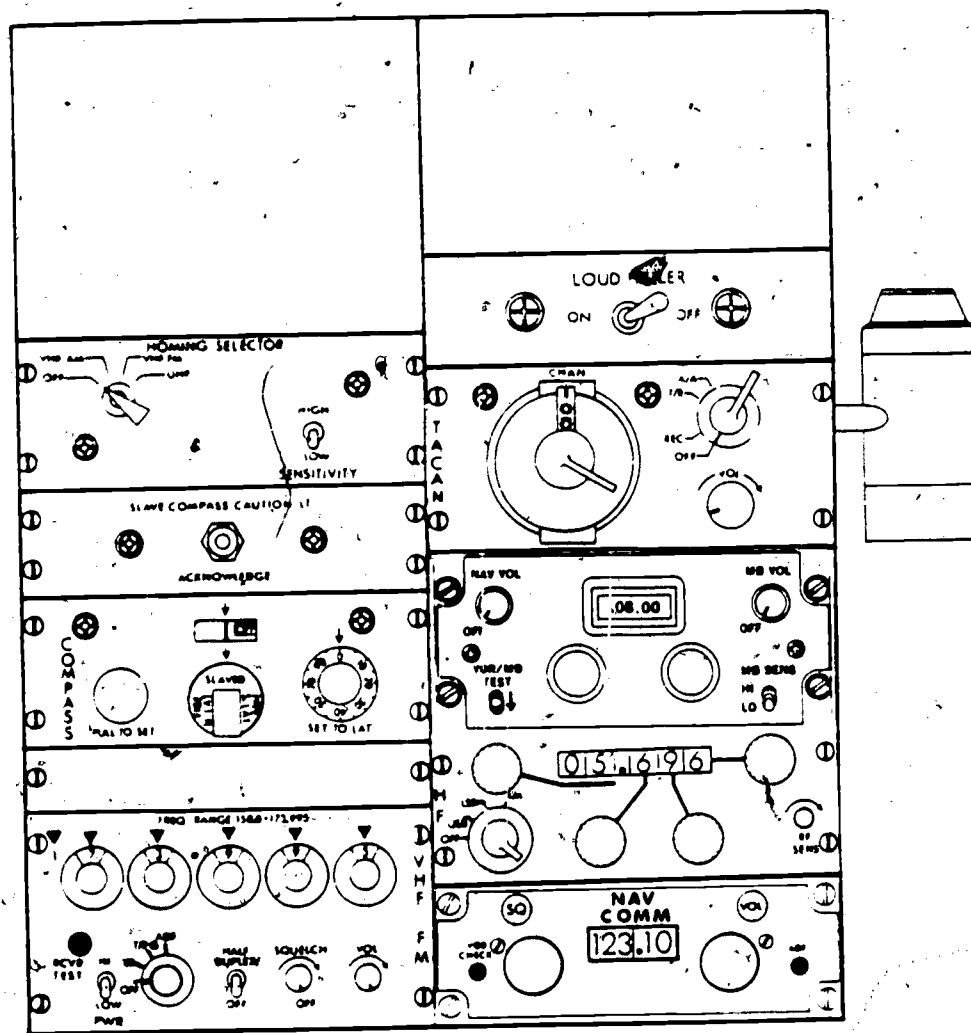
Remote Display Unit

The remote unit is a digital display located on the upper left of the pilot's instrument panel. The unit provides a heads-up display of long track information, which is from present position to waypoint selected. The information is displayed in nautical miles.

GVR/LORAN Selector Switch

The GVR/LORAN selector switch is located on the pilot's instrument panel below the remote display unit. The switch provides Loran information to the flight director. The flight director will display the information, provided G has been selected. The position of the switch is indicated by illumination of the appropriate section of the switch -- GVR or LORAN.

Page 10-25: Replace Figure 10-20 with attached figure.



UPPER RADIO CONSOLE

Figure 10-20. - Radio Consoles.

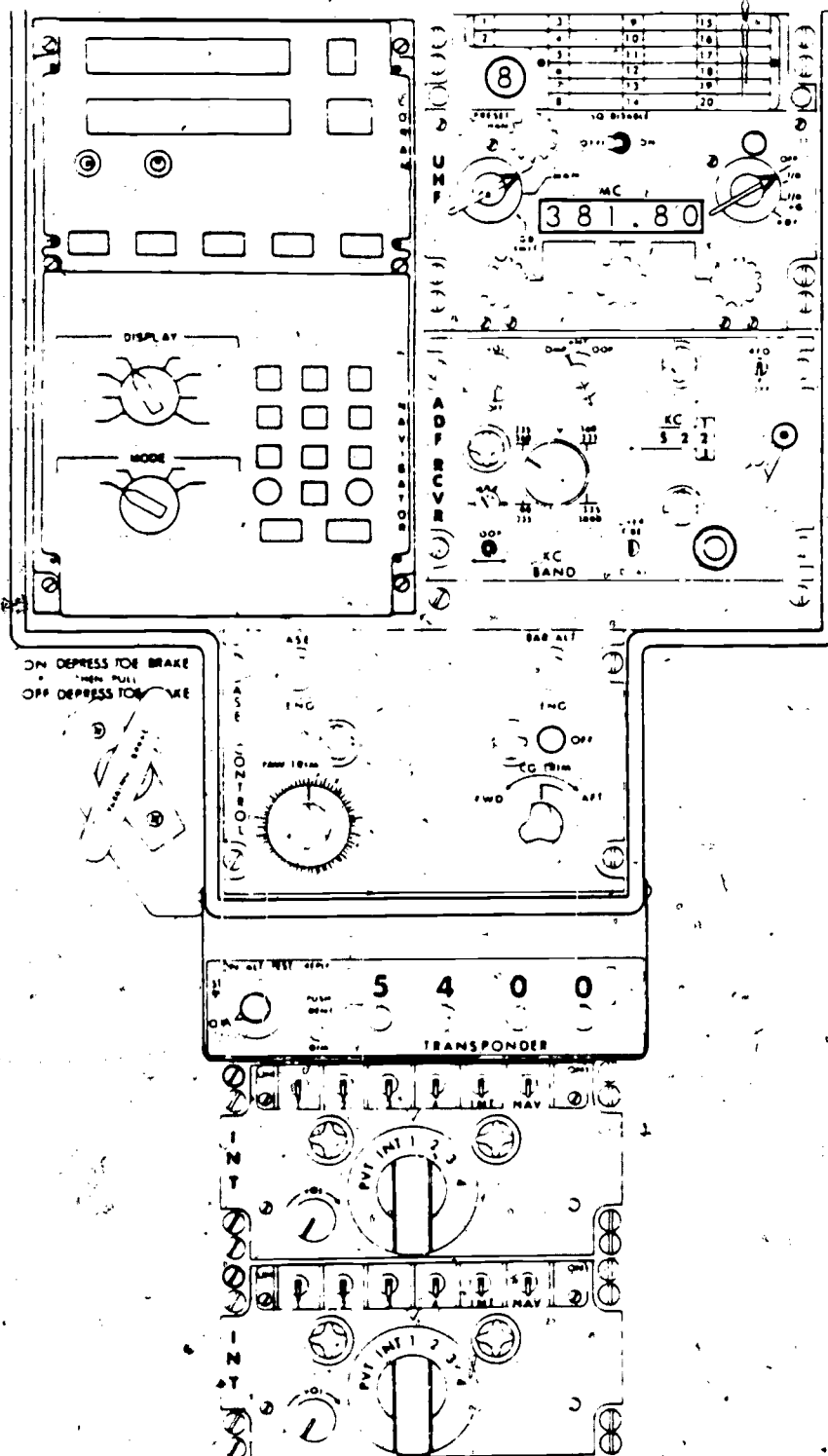
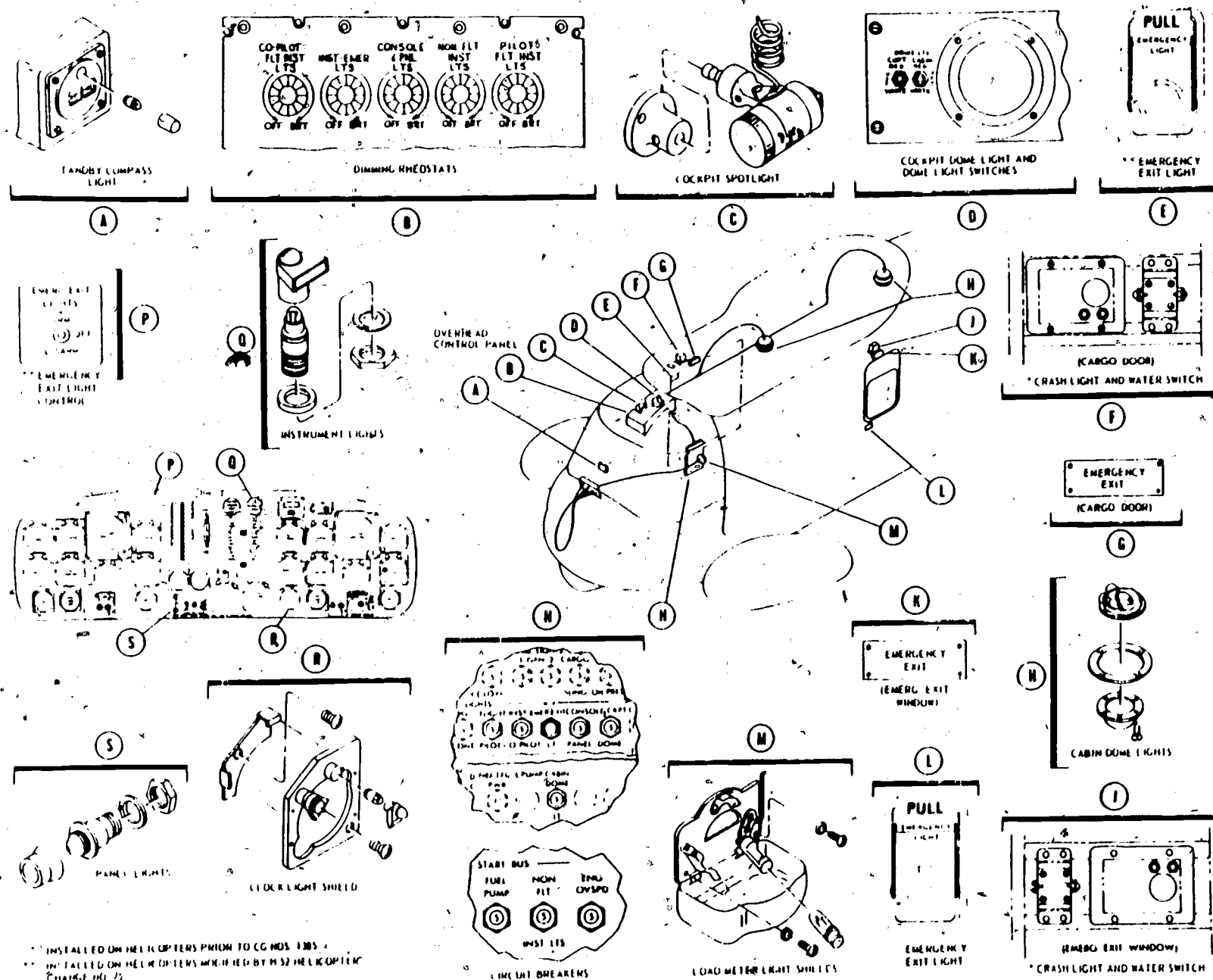


Figure 8-3. - Internal Lighting



* INSTALLED ON HELICOPTERS PRIOR TO CG MOD 1305.
 ** INSTALLED ON HELICOPTERS MANUFACTURED BY MS2 HELICOPTER
 PARTIAL 101/25



U.S. COAST GUARD

U.S. COAST GUARD INSTITUTE
HH-3F
POWER TRAIN
OKLAHOMA CITY

DEPARTMENT OF TRANSPORTATION
U. S. Coast Guard (07/80)

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U. S. Coast Guard Institute
PAMPHLET NO. 660

This pamphlet contains original material developed at the
Coast Guard Institute and also excerpts from:

HH-3F Flight Manual

T.O. 1H-3(H)F-1

HH-3F Maintenance Manuals

T.O. 1H-3(H)F-2

IMPORTANT NOTE: In July, 1980, the information contained in this pamphlet was current according to the latest updates of those Directives/Publications listed. This pamphlet was compiled for training **ONLY**. It should **NOT** be used in lieu of official Directives or publications. It is always **YOUR** responsibility to keep abreast of the latest professional information available for your rate.

The personnel responsible for the latest review and
update of the material in this component during July 1980 are:

ATCS B. L. Ely (Subject Matter Specialist)

B. J. Quick (Education Specialist)

YN1 K. M. Baker (Typographer/Typist)

INTRODUCTION

This pamphlet will help you gain a thorough understanding of the HH-3F helicopter power train. We will cover the main rotor assembly, transmission system, flight control system, and the T58-GE-5 engine.

We will present the T58 engine in depth. After studying this material, you should be familiar enough with the engine to perform engine wash and rustlick operations.

Finally, the pamphlet includes instructions for ground handling and servicing. By following these instructions, you can safely and properly handle and service your aircraft at home or on extended flights.

NOTE: COMPLETE PAMPHLET 659 PRIOR TO BEGINNING STUDY OF THIS MATERIAL.

NOTICE TO STUDENT

This pamphlet contains lesson quizzes. Correct answers and text references are printed in the right hand column of each quiz page. Cover the answers in the right hand column. After you answer the questions, remove the cover to check your answer with the printed answer. Try to answer the questions in each quiz before looking back at the text.

MAIN ROTOR ASSEMBLY

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the main rotor blades and pressure indicators.
2. Describe the main rotor head.
3. Identify the components of the main rotor head and explain their function.
4. Summarize the operation of the rotor brake system.

The action of the main rotor assembly and the movement of the helicopter are the result of an application of machines to the theory of flight. The blade assemblies and rotor head convert the helicopter's engine power into lift and directional control. The airfoils are rotated through the air to produce a relative wind, and the rotor head permits changing the angle of attack, which can alter both the magnitude and direction of the helicopter's movement. You already know the principles involved in the theory of flight, so this pamphlet will relate to the mechanics of helicopter flight. We will discuss the function and structure of the main rotor blades, the main rotor head assembly, and the main rotor controls.

MAIN ROTOR BLADES (See figure 1.)

Five blades, installed on the main rotor head, provide the lift necessary for flight. Each blade consists basically of a hollow extruded aluminum spar, 23 aluminum pockets, an aluminum root cap, a steel cuff, a pressure indicator, an air valve, an abrasion strip, and a tip fairing. The cuff provides the means for attaching the blades to the rotary wing head sleeve-spin- nles, while the abrasion strip protects the leading edge of the blade against erosion. Vent holes on the underside of each pocket prevent accumulation of moisture inside the blade. Each blade is balanced statically and dynamically within tolerances that permit individual replacement of the blades. In addition, a pretrack number is stenciled on each blade to eliminate the necessity for blade tracking. Balancing and assignment of a pretrack number are done at

manufacture or overhaul. The main rotor blade spars are sealed units, pressurized with nitrogen. If an unforeseen combination of events should occur impairing the structural integrity of the spar, or if a seal should leak, the nitrogen will leak from the spar. If the pressure in the spar drops below the minimum permissible service pressure, the pressure indicator will show red. Also, anti-icing tape, if installed on the blade leading edge, aids in preventing ice formation during adverse weather conditions.

IBIS (IN FLIGHT BLADE INSPECTION SYSTEM)

INDICATORS (See figure 2.)

Helicopters modified by the TCTO IH- (H)F-580 are equipped with an In-Flight Blade Inspection system (IBIS), that visibly indicates in the cockpit that the pressure in one or more main rotor blade spars has dropped below the allowable limit.

The IBIS indicator, located on the back wall of the spar of each main blade, contains a small radioactive source (100 micro curies strontium 90) which is completely shielded and emits no radiation when the rotor blade is at normal pressure. When the pressure in the rotor blade spar drops below 6.1 (+0.4) psi, the indicator will activate, causing the radioactive source to move to an unshielded position, thereby emitting beta radiation. The detector assembly, located aft of the main rotor shaft under the transmission cooling, detects the beta radiation and sends a signal to the blade processor. The signal processor causes the BLADE PRESS light on the caution panel to illuminate, indicating a loss of pressure in one or more of the blade

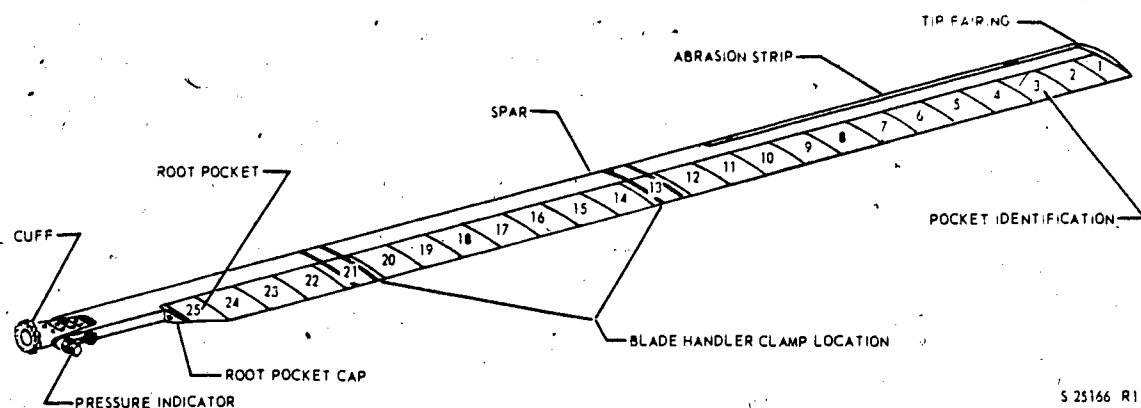


Figure 1. - Main rotor blade.

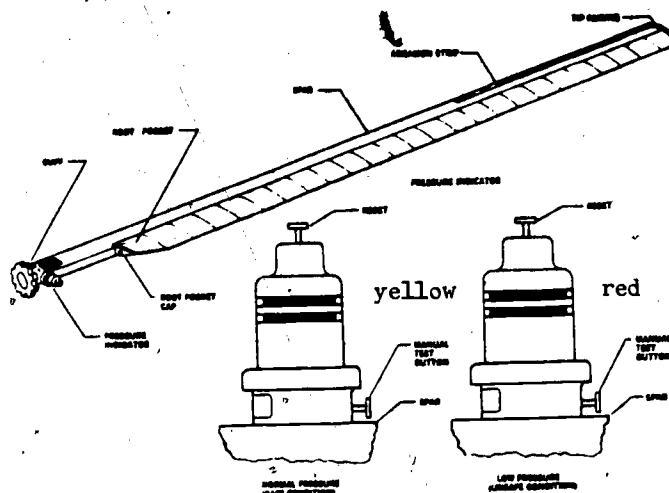


Figure 2. - IBIS Indicator.

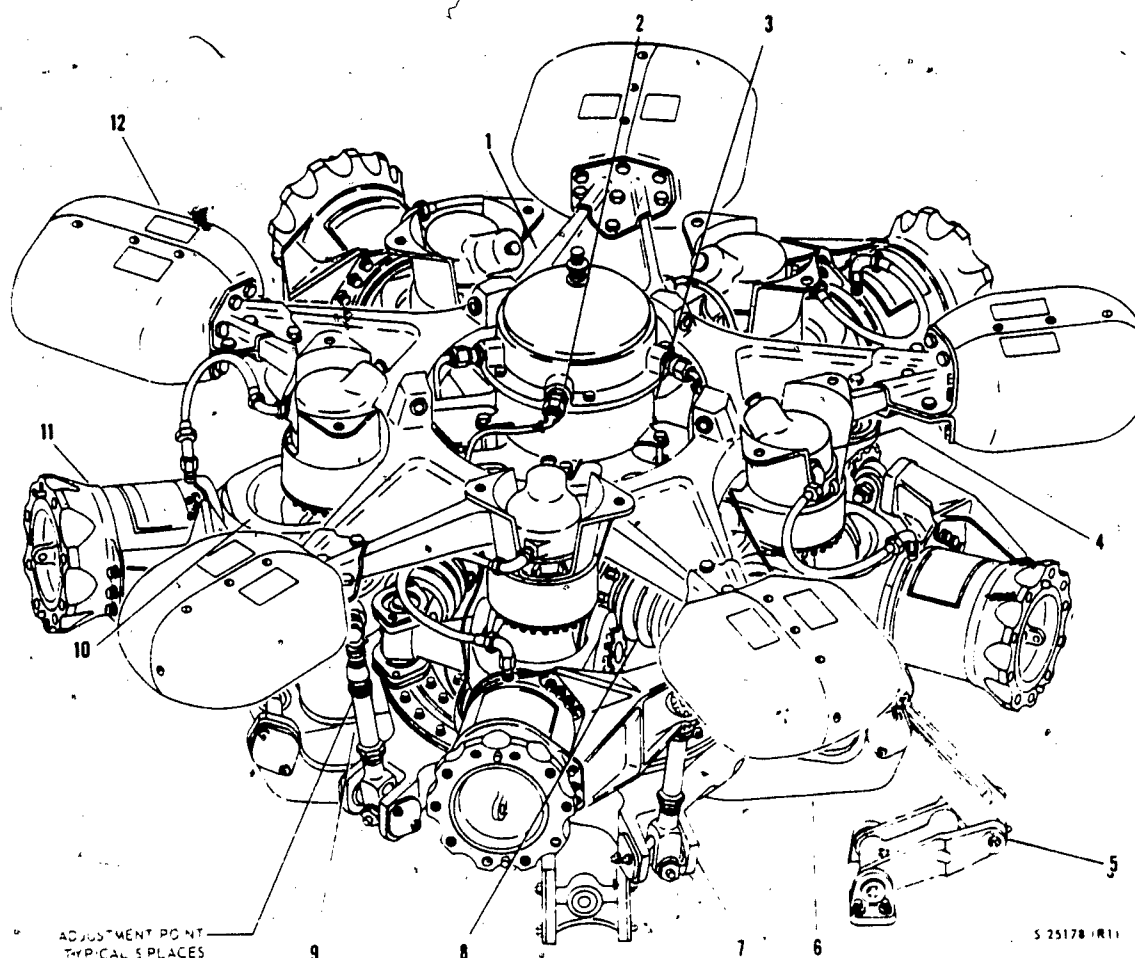
spars. Loss of pressure in the blade spar is also indicated by the IBIS indicator located in the back wall of the spar of each main blade. The indicator, compensated for temperature changes, compares a reference pressure built into the indicator with the pressure in the blade spar. When the pressure in the blade spar is within the required service limits, two yellow stripes show in the indicator. If the pressure in the blade spar drops below the minimum permissible service pressure, the indicator will be activated and will show two red stripes. Loss of 115 volt ac power, failure of the detector, and/or failure of the signal processor will cause the BLADE PRESS caution light to illuminate. The system receives electrical power from the No. 1 ac primary bus and is protected by a circuit breaker on the copilot's overhead circuit breaker panel marked IBIS, under the general heading DC PRI.

WARNING

When red is visible in the indicator, the cause of the red indication shall be determined before accepting the helicopter for flight.

MAIN ROTOR HEAD (See figure 3.)

The main rotor head is splined to and supported by the main rotor shaft of the main gear box. The rotor head and the five main rotor blades attached to it are rotated by torque from the main gear box through the main rotor shaft. Principal components of the main rotor head are the hub and swashplate (items 6 and 7.) The hub consists of a hub plate, lower plate, hinges, sleeve-spindles (10 and 11), dampers (8), anti-flapping restrainers, droop restrainers, and pitch control rods (9). The hinges, attached between each arm of the hub plate and lower plate, serve as mounts for the sleeve-spindles to which the main rotor blades are attached. The hinges permit vertical and horizontal movement of the blades so they can lead, lag, and flap, but the dampers restrict the lead and lag motions. The anti-flapping and droop restrainers prevent flapping motion when the rotor is slowing or stopped. The swashplate consists of a rotating swashplate and a stationary swashplate. The stationary swashplate (6) is connected to the main gear box by the stationary scissors (5) and primary servo-cylinders. The rotating swashplate (7) rotates within the stationary



- | | | | |
|--------------|-------------------------|--------------------------------|-------------------------------|
| 1 Fluid Tank | 4 Oil Tank | 7 Rotating Swashplate | 10 Spindle |
| 2 Union | 5 Stationary Scissors | 8 Damper | 11 Sleeve |
| 3 Spacer | 6 Stationary Swashplate | 9 Adjustable Pitch Control Rod | 12 Bifilar Vibration Absorber |

Figure 3. - Main rotor head.

swashplate and is connected to the hub by the rotating scissors and pitch control rods. Flight control movement is transmitted to the primary servos through the stationary and rotating swashplates. Movement of the rotating swashplate is transmitted to the main rotor blades through the pitch control rods connected to the sleeve spindles.

NOTE

The main rotor head is pretrack rigged at manufacture, overhaul, before installation, or on the helicopter. Once the main rotor head is pretrack rigged,

re-rigging is not required unless the main rotor head, swashplate, horn eyebolt or an adjustable pitch control rod is changed.

DAMPERS (See figure 4.)

A damper is mounted between the hub plate and the lower plate and secured to the horizontal hinge pin. The damper controls the horizontal movement of each main rotor blade. When the main rotor is started or stopped, the damper absorbs the shock of the blades. Hunting of the blades, when the load on the blades is suddenly increased

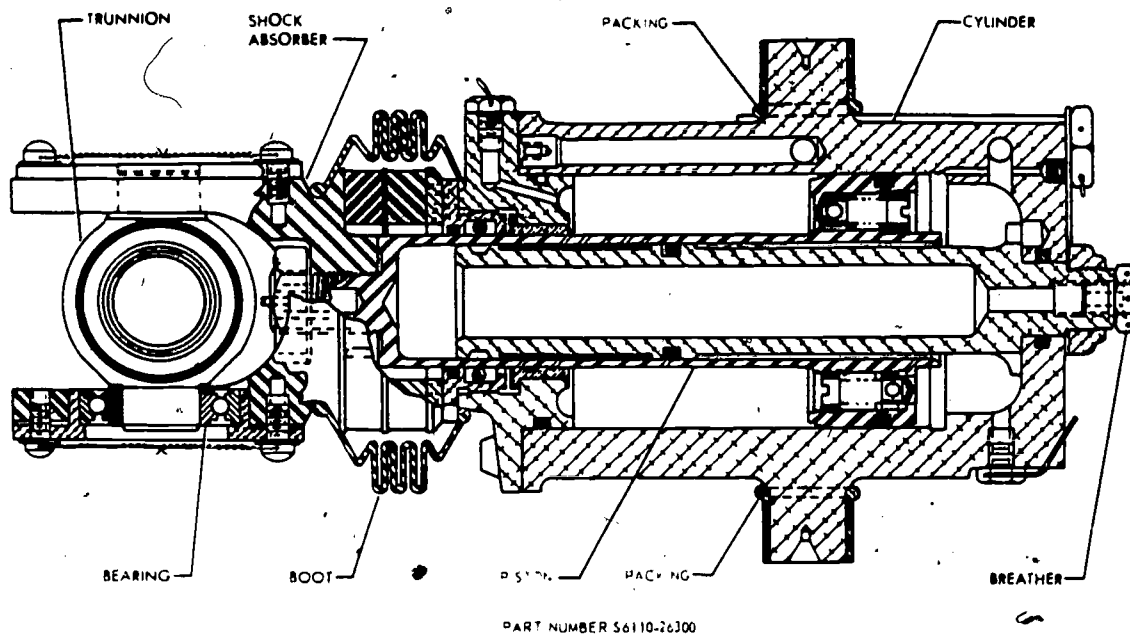


Figure 4. - Damper - cross - sectional view.

or decreased, is also controlled by the dampers. When a blade moves horizontally on its vertical hinge, the length of the damper must change, and as the piston moves back and forth in the cylinder, the hydraulic fluid is metered from one side to the other. The rate-of-flow determines the amount of restriction imposed on the blade. The primary restrictive function of the damper is on the ground in starting and stopping. In flight, where sudden movements of the blade occur with great force, relief valves in the piston open in opposite directions to permit almost unrestricted movement of the piston. Travel of the piston is limited by stops at each end of the piston rod. The rubber shock absorber acts as a cushioned stop and sets the extreme lag position of the blade. A differential check valve assembly, mounted on the damper, permits hydraulic fluid to enter either side of the damper as required, to automatically bleed the dampers during operation.

A tank (figure 3, item 1) on the top of the hub plate serves as a reservoir for the dampers. Markings on the transparent plastic top indicate the required fluid level. A strainer in the tank prevents contamination when hydraulic fluid is added to the system.

DROOP RESTRAINERS (See figure 5.)

A droop restrainer on the vertical hinge of each blade limits droop of the blades when the main rotor head is slowing or stopped. When the main rotor head is rotating, centrifugal force throws the cam arms out and permits increased vertical movement of the blades.

ANTI-FLAPPING RESTRAINERS (See figure 5.)

An anti-flapping restrainer is installed between each of the five main rotor vertical hinges and sleeve-spindles. Anti-flapping restrainers are spring-loaded locks which prevent main rotor blades from flapping on their horizontal hinges when the main rotor head is slowing or stopped. When the main rotor is rotating, centrifugal force holds the anti-flapping restrainers outward from the locked position, thus permitting free flapping and coning of the main rotor blades.

STATIONARY SCISSORS (See figures 6 and 7.)

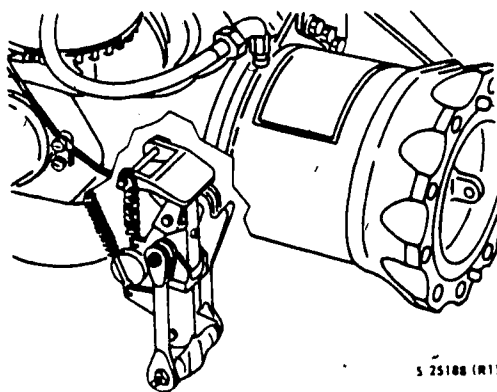


Figure 5. - Droop and anti-flapping restrainers - installed.

freely up and down or tilt on the main rotor shaft.

SWASHPLATE (See figures 10 and 11.)

The swashplate transmits the movement of the flight controls to the main rotor blades through the sleeve-spindles. A ball-ring (spherical bearing) and sockets allow the swashplate to be tilted off its horizontal plane and moved on its vertical axis. The swashplate consists of a rotating swashplate connected to the main rotor hub by the rotating scissors and pitch control rods, and a stationary swashplate connected to the main gear box by the stationary scissors and the servo-cylinders. Each

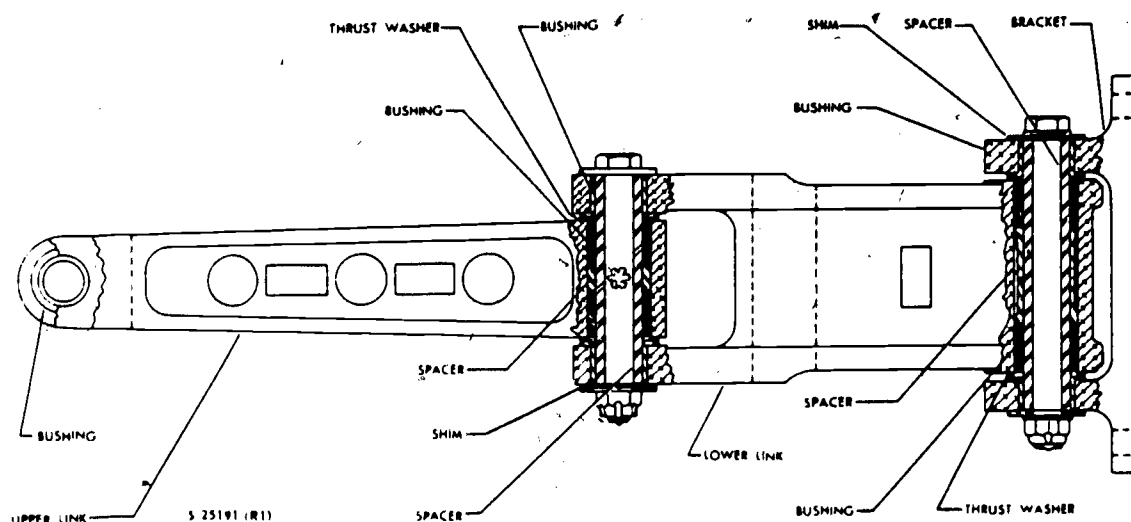


Figure 6. - Stationary scissors - cross-sectional view.

The stationary scissors are installed between the main gear box (6, figure 7) and the stationary swashplate (2). The stationary scissors prevent the stationary swashplate from rotating with the main rotor head while permitting it to move freely up and down or tilt on the main rotor shaft.

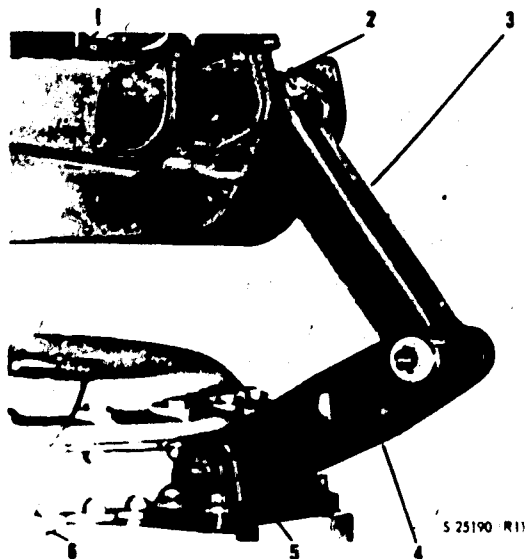
ROTATING SCISSORS (See figures 8 and 9.)

The rotating scissors are attached to a bracket (1, figure 8) on the bottom of the main rotor hub lower plate and to a bracket (4) on the rotating swashplate. The rotating scissors are a torque arm that causes the rotating swashplate to rotate with the main rotor head while permitting it to move

swashplate is bolted together in a manner that permits the rotating swashplate to rotate within the stationary swashplate. When the servocylinders, connected to the stationary swashplate, are actuated by the flight controls, the movements of the stationary swashplate are transmitted to the rotating swashplate. From the rotating swashplate, the control movements are transmitted by the pitch control rods to the horns of the sleeve-spindle to change the angles of incidence of the blades.

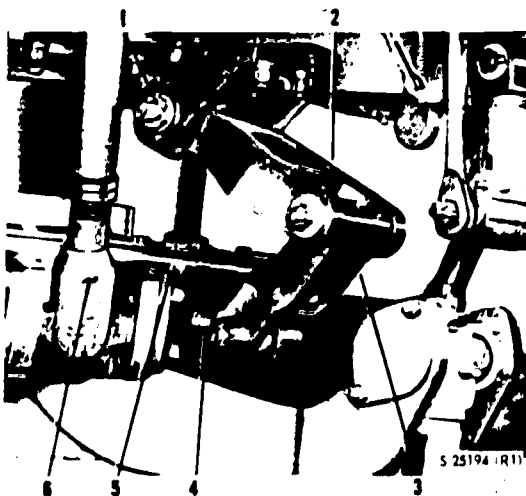
PITCH CONTROL RODS

Figure 12 illustrates a pitch control rod (item 3) which extends from the sleeve-spindle horn to the rotating swashplate.



- | | |
|-------------------------|-----------------|
| 1 Rotating Swashplate | 4 Lower Link |
| 2 Stationary Swashplate | 5 Bracket |
| 3 Upper Link | 6 Main Gear Box |

Figure 7. - Stationary scissors installed



- | | |
|-----------------|--------------------------------|
| 1 Upper Bracket | 5 Rotating Swashplate |
| 2 Upper Link | 6 Adjustable Pitch Control Rod |
| 3 Lower Link | |
| 4 Lower Bracket | |

Figure 8. - Rotating scissors - installed.

All flight control movements of the swashplate are transmitted by the control rods to the main rotor blades. Micrometer-type

decals are mounted near the upper locknut to permit adjustment of the control rods during tracking operations of the main rotor blades.

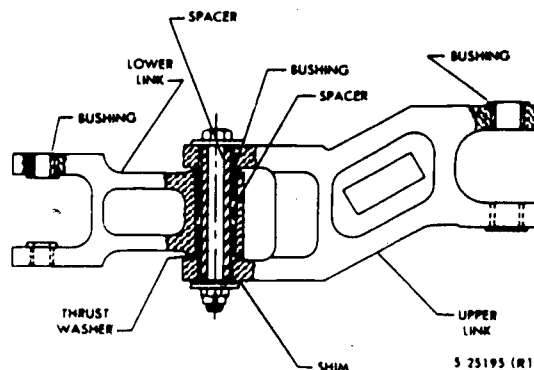


Figure 9. - Rotating scissors cross-sectional view

SLEEVE AND SPINDLE

The sleeve and spindle (figure 13, item 2) of the main rotor hub assembly transmits pitch to the main rotor blades through the control rods. A main rotor blade attaches directly to each sleeve and spindle assembly.

OIL TANKS

Five oil tanks (figure 3, item 4), mounted on the hinges, serve as reservoirs for lubricating oil. Each tank is connected to the sleeve-spindle by a hose. Each tank lubricates its respective upper and lower hinge bearing, horizontal hinge bearings, and stack bearing in the sleeve-spindle.

BIFILAR VIBRATION ABSORBER (Figure 14.)

The bifilar vibration absorber consists of a five-armed, star-shaped aluminum forging. A seventeen-pound steel weight (19) is attached through two pendulum pivot points at the end of each arm, and weights are secured to the pivot points by bolts clamping two bushings (20) against two tapered washers (11 and 17). The washers center the weights against the contact surfaces and supply vertical support under static conditions. The bifilar arms have an I-beam cross section to provide structural efficiency. The bifilar is secured to the main

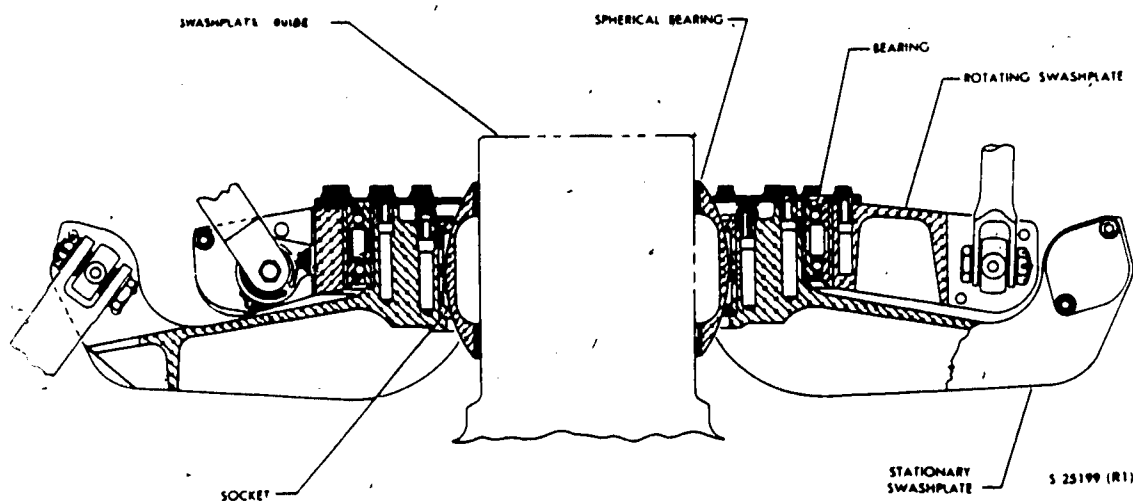
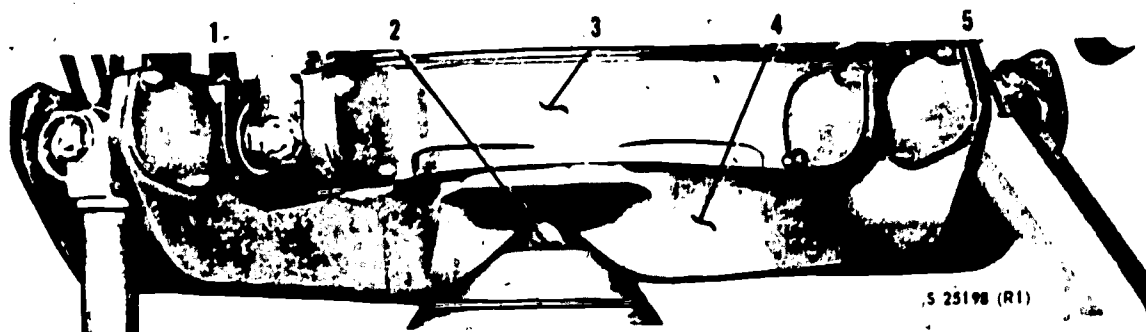


Figure 10. - Swashplate - cross-sectional view.



1 Adjustable Pitch Control Rod

2 Main Rotor Shaft

3 Rotating Swashplate

4 Stationary Swashplate

5 Stationary Scissors

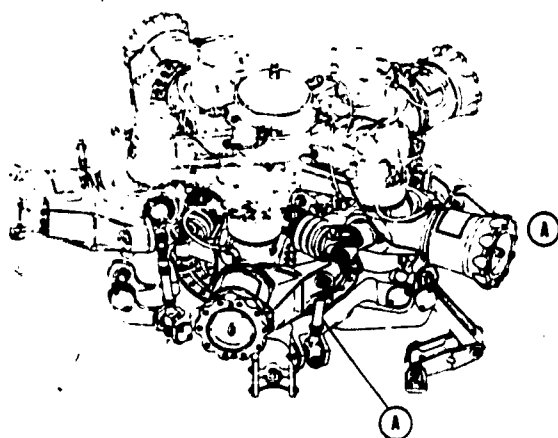
Figure 11. - Swashplate - installed.

rotor hub at five attachment points on the hub arms. The attachment points consist of two existing holes in each arm normally used for hoisting the helicopter and securing the blade pretrack fixture. The attachment uses five thru bolts (one per hub arm) with associated shims to provide attachment. Each weight is enclosed by an aerodynamically shaped fairing (8 and 9) to reduce rotor drag and provide a controlled environment for the contacting surfaces of the weight pivot points.

ROTOR BRAKE SYSTEM

The rotor brake system (shown in figure 15) consists of a master cylinder (6),

rotor brake (1), pressure switch (3), pressure gage (5), pressure relief valve (7), accumulator (4), and reservoir (2). Pressure is developed by actuating the master cylinder handle, which extends the rotor brake puck-faced piston, stopping main rotor head rotation. A minimum hydraulic pressure of 350 psi, as indicated on the pressure gage, is required for effective brake operation. The pressure switch actuates at 10 ± 1 psi, permitting electrical power to illuminate the ROTOR BRAKE light capsule on the caution/advisory panel. If pressure exceeds 600 ± 20 psi, the relief valve cracks, venting pressure to the gravity supply line. The accumulator maintains a constant pressure in the system once the



S 23200 (R1)

- | | | | |
|-----------------------|-----------------------|------------|-----------|
| 1 Horn | 4 Bolt, Washers, Nut, | 7 Washers | 11 Clevis |
| 2 Bolt, Washers, Nut, | Cotter Pin | 8 Shim | 12 Shim |
| Cotter Pin | 5 Rotating Swashplate | 9 Locknut | 13 Link |
| 3 Pitch Control Rod | 6 Clevis | 10 Locknut | 14 Key |

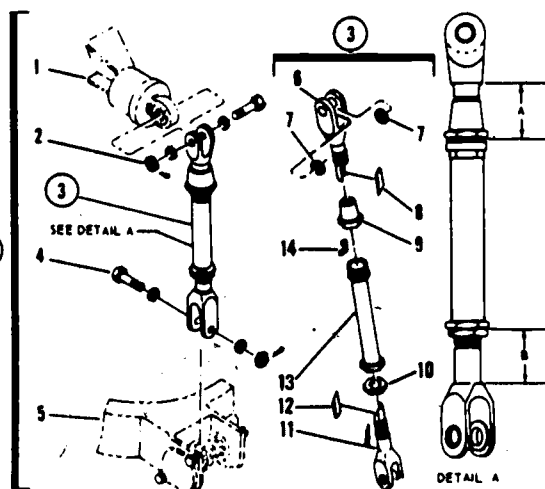


Figure 12. - Pitch control rod.

rotor brake is applied, compensates for variation in pressure due to temperature change, and dampens out system pressure surges. Hydraulic fluid for system operation is gravity fed to the master cylinder from the reservoir.

ROTOR BRAKE MASTER CYLINDER

The cylinder (figure 15, item 6), on the right side of the overhead control panel, actuates the rotor brake. The cylinder is gravity fed with hydraulic fluid from the rotor brake reservoir. The brake handle is manually actuated down and forward to apply hydraulic pressure to the rotor brake system. A spring latch on the cylinder linkage locks the handle in the on or parked position. To release the brake, the latch must be pulled and the handle returned to the detent or off position. The latch can be locked out of position by pulling the latch and rotating it 90 degrees. A pressure gage adjacent to the master cylinder indicates the amount of pressure produced by the master brake cylinder. A check valve is provided to pressure bleed the system. A minimum of 350 psi pressure is required for effective rotor brake operation.

ADVISORY LIGHT SYSTEM (Figure 15)

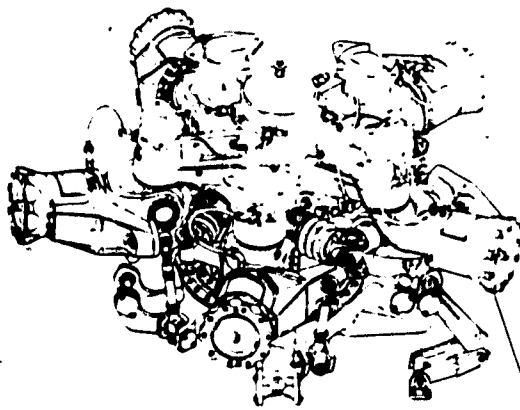
The system consists of a pressure switch, ROTOR BRAKE light capsule on the caution/advisory panel, and a ROTOR BRAKE circuit breaker on the overhead control panel. When system pressure reaches 10 ± 1 psi, the pressure switch contacts close allowing electrical power to flow to the caution/advisory panel to illuminate the ROTOR BRAKE light capsule.

PRESSURE SWITCH

The pressure switch (figure 15, item 3) is on the side of the forward transmission support. The switch actuates when hydraulic line pressure in the rotor brake system reaches 10 ± 1 psi. Access to the switch is gained by hinging down the transmission service platform.

PRESSURE RELIEF VALVE

The pressure relief valve (figure 15, item 7) is on the left side of the forward transmission support beam. The valve is



S 25202 (R1)

- 1 Hose
- 2 Sleeve and Spindle
- 3 Plugs
- 4 Screws, Washers
- 5 Grounding Cable

- 6 Anti-flapping Spring
- 7 Locknut
- 8 Lockwasher
- 9 Thrust Washers
- 10 Damper Trunnion

- 11 Horizontal Pin
- 12 Key
- 13 Adapter
- 14 Pitch Control Rod

- 15 Bolt, Washers, Nut, Cotter Pin
- 16 Lockwasher
- 17 Locknut

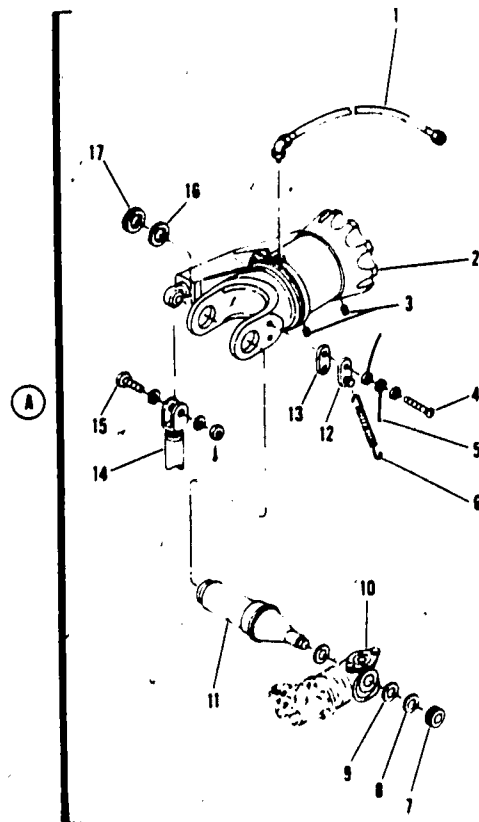


Figure 13. - Sleeve and spindle:

designed to relieve system pressure at 600 ± 20 psi. Fluid vented by opening the relief valve is returned to the gravity feed supply line.

ACCUMULATOR (Figure 16)

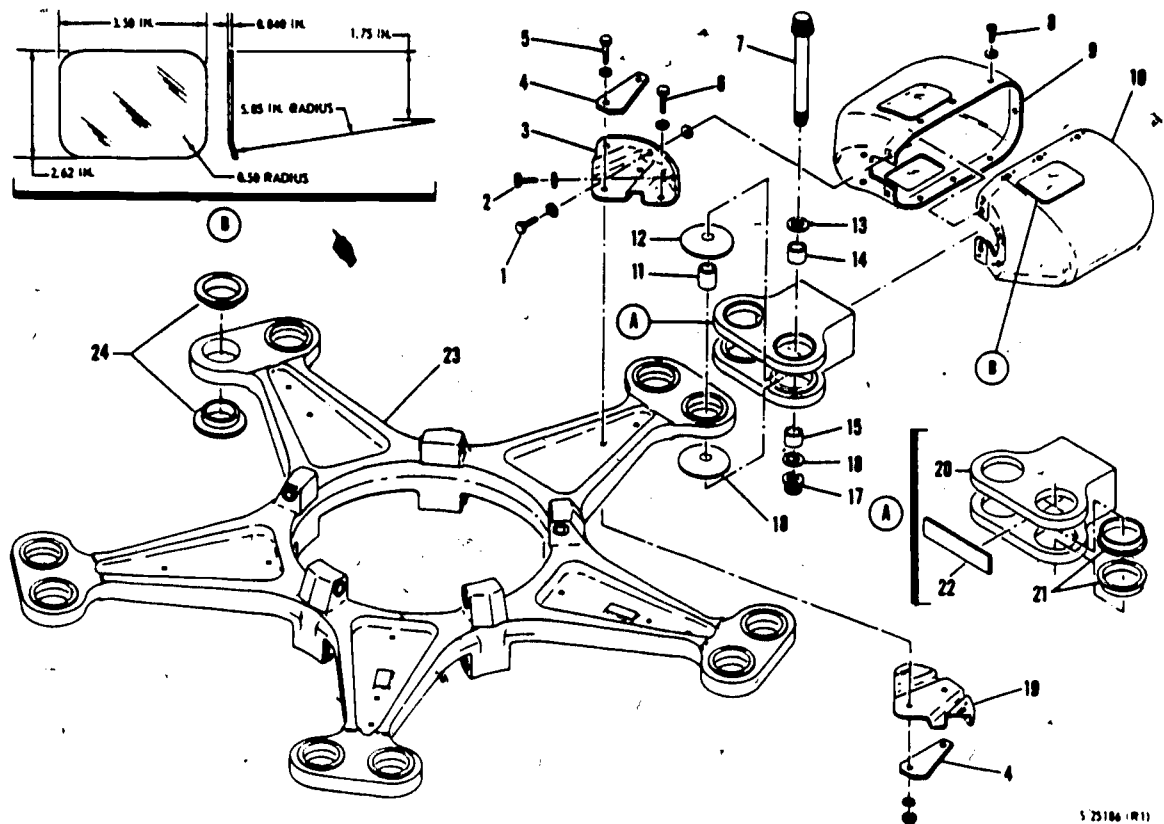
The accumulator, on the left side of the transmission wall, is a spring-loaded hydraulic type. Once the rotor brake is applied, the accumulator keeps a constant pressure in the rotor brake system. The accumulator also compensates for variations in line pressure due to changes in temperature and pressure surges.

ROTOR BRAKE RESERVOIR

The reservoir (figure 15, item 2), aft and to the right of the main gear box, supplies hydraulic fluid for the rotor brake system. When filled to the FULL mark, the reservoir contains approximately 3.2 ounces of hydraulic fluid.

ROTOR BRAKE (Figure 17)

The rotor brake is a self-adjusting unit consisting of two housing halves, a bracket, and a rotor brake disc. The rotor brake disc is on the input bevel gear shaft flange extending through the main gear box

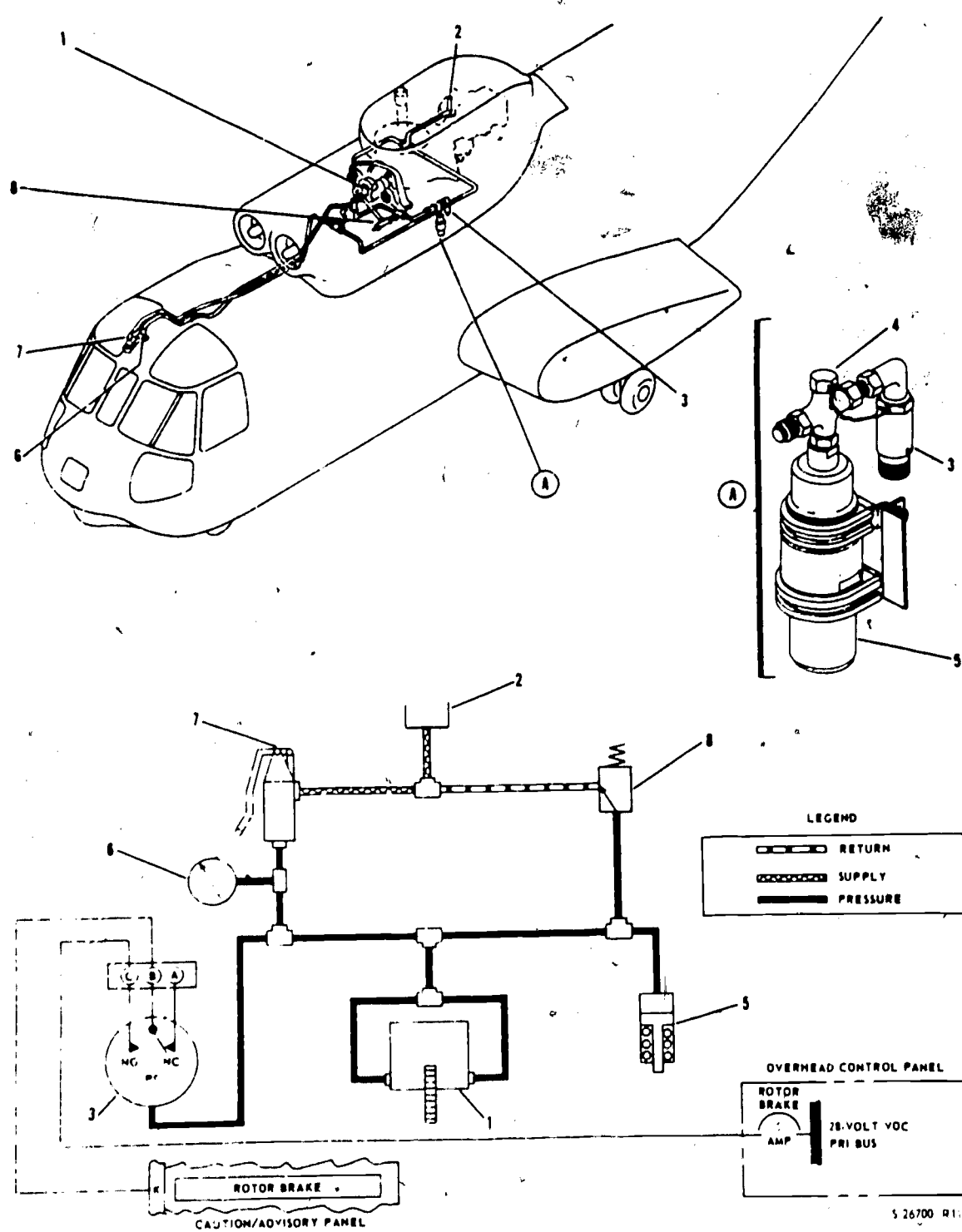


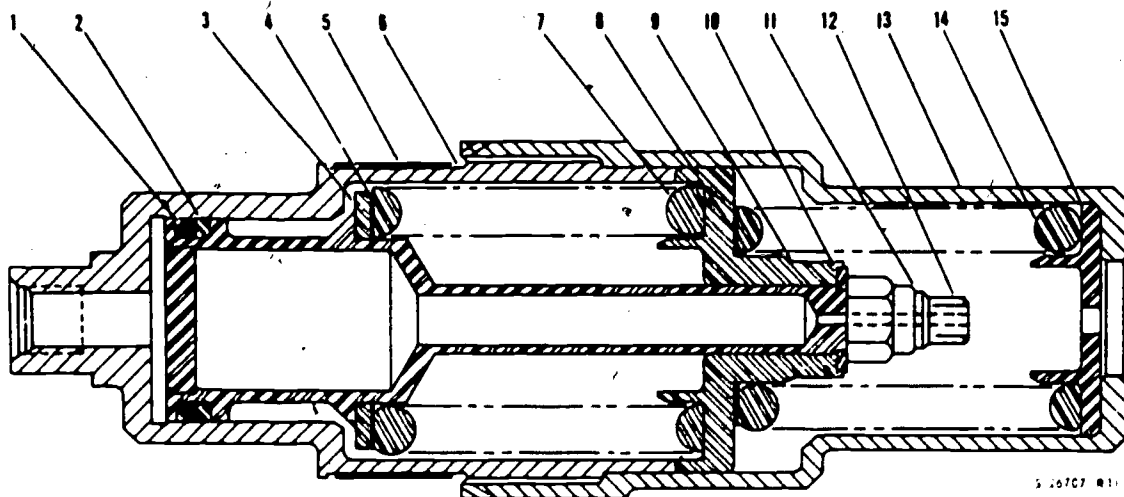
- | | | | |
|----------------------|---------------------|---------------------|--------------------|
| 1 Bolt, Washers | 7 Bolt | 13 Washer | 19 Support (Cover) |
| 2 Bolt, Washer | 8 Screw, Washer | 14 Spacer | 20 Weight |
| 3 Support (Cover) | 9 Cover (Forward) | 15 Spacer | 21 Bushings |
| 4 Retainer | 10 Cover (Aft) | 16 Washer | 22 Bumper |
| 5 Bolt, Washers, Nut | 11 Spacer | 17 Nut | 23 Support |
| 6 Bolt, Washer | 12 Washer (Tapered) | 18 Washer (Tapered) | 24 Bushings |

Figure 14. - Bifilar vibration absorber - disassembled.

input cover. The bracket on which the housing halves are assembled is mounted so that the brake disc rotates between the two halves. Each half contains two hydraulically actuated, puck-faced pistons. As the opposed

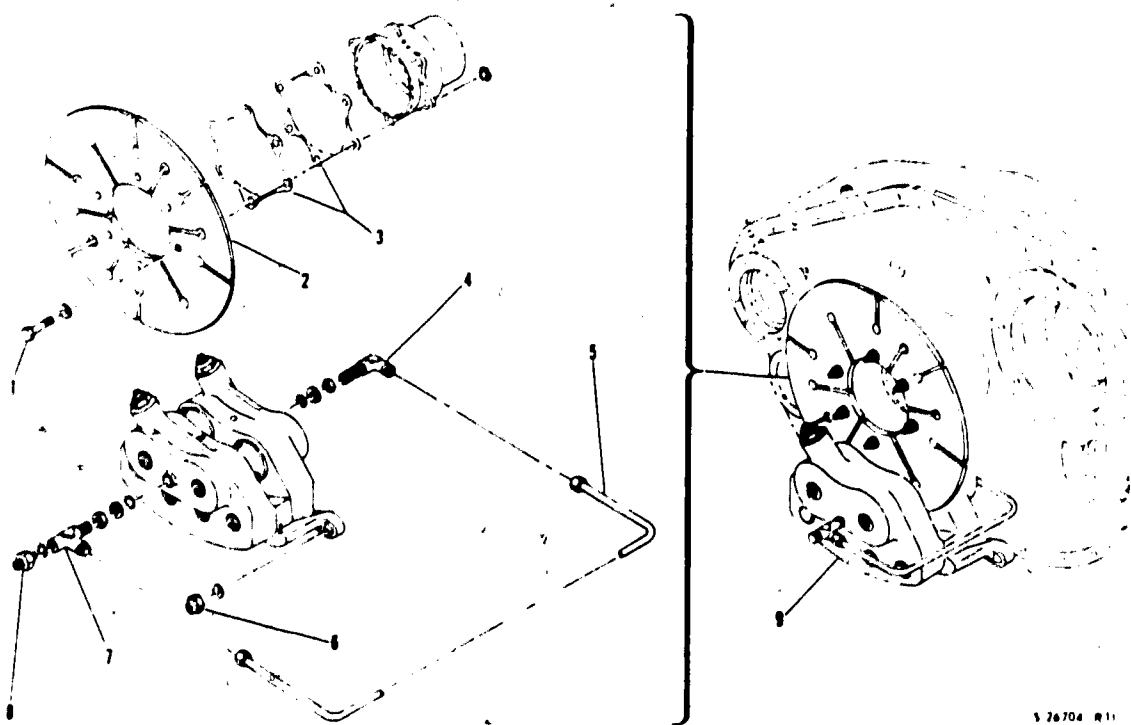
pistons extend, the pucks contact the rotating disc from both sides, providing a braking action capable of stopping main rotor rotation in 14 seconds from 157 rpm.





- | | | | |
|----------------|--------------|-------------|------------|
| 1 Packing | 5 Name Plate | 9 Stop | 13 Housing |
| 2 Back-up Ring | 6 Body | 10 Washer | 14 Spring |
| 3 Plate | 7 Spring | 11 Lock Nut | 15 Guide |
| 4 Shim | 8 Shim | 12 Piston | |

Figure 16. - Rotor brake accumulator.



- | | | | |
|---------------------|----------------------------|--------------------------|-------------------|
| 1 Bolt, Washer, Nut | 4 Elbow, Nut, Gasket, Ring | 6 Washer, Nut | 8 Reducer, Gasket |
| 2 Rotor Brake Disc | 5 Tube | 7 Tee, Nut, Gasket, Ring | 9 Rotor Brake |
| 3 Shims | | | |

Figure 17. - Rotor brake.

REVIEW

We have discussed the main rotor blades, main rotor head, and rotor brake system. Since these are very important parts of the aircraft, you must be extra cautious when preflighting them.

/ (Now answer the following review questions.)

1. Which component of the rotor blade provides the means of attaching the blade to the hub?

- A. Cuff
- B. Tip cap
- C. Root pocket
- D. Root pocket cap

1.-A (Refer to page 1)

2. Which statements below concerning main rotor blades are TRUE?

- 1. Each blade is individually balanced.
- 2. A pretrack number is stenciled on each blade.
- 3. Vent holes in the pockets are designed to permit air pressure equalization.
- 4. Balance and pretrack number assignment are done at overhaul.
- 5. Blade tracking is not necessary after you replace an individual blade.

- A. 1 and 3 only
- B. 2, 3, and 5 only
- C. 1, 2, 4, and 5 only
- D. 1, 2, 3, 4, and 5

2.-C (Refer to page 1)

3. Which color on a blade pressure indicator indicates a NORMAL condition?

- A. Grey
- B. Green
- C. Yellow
- D. White

3.-C A red indication could indicate an unsafe blade condition. (Refer to pages 1 and 2)

4. The movements of the flight controls are transmitted to the rotor blades through the _____.

- A. swashplate and pitch control rods
- B. anti-flap restrainers and pitch control rods
- C. pitch control rods and stationary scissors
- D. swashplate and rotating scissors

4.-A (Refer to page 3)

5. The extreme LAG position of the main rotor blade is determined by the _____ in the damper assembly.

- A. rubber shock absorber
- B. differential check valve
- C. packing gland
- D. restrictor

5.-A (Refer to page 4)

6. Anti-flapping restrainers are designed to be effective when the rotor is _____.

- A. rotating at any operating rpm
- B. rotating above 100 rpm
- C. rotating between 50 and 100 rpm
- D. slowing or stopped

6.-A (Refer to page 4)

7. The rotating scissors form a link between which of the following?

- 1. Main rotor hub
- 2. Stationary swashplate.
- 3. Main transmission
- 4. Rotating swashplate

- A. 1 and 2
- B. 2 and 3
- C. 3 and 4
- D. 1 and 4

7.-D (Refer to page 5)

8. Which of the following permit(s) the swashplate to be tilted off its horizontal plane?

- 1. Ball bearing
- 2. Socket
- 3. Ball-ring
- 4. Pitch control rods

- A. 1 only
- B. 3 only
- C. 2 and 3 only
- D. 1, 2, and 4

8.-C (Refer to page 5)

9. Which component connects the sleeve-spindle horn to the rotating swashplate?

- A. Rotating scissors
- B. Pitch control rod
- C. Stationary scissors
- D. Link assembly

9.-B (Refer to page 5)

10. Which statement is NOT true concerning the bifilar vibration absorber?

- A. It is a five-armed aluminum forging
- B. It uses a 17-pound steel weight
- C. The bifilar arms have an H-beam cross section
- D. Each weight is enclosed in a special fairing

10.-C. (Refer to page 6)

11. For effective rotor brake operation, you must develop a MINIMUM _____ psi with the rotor brake handle.

- A. 10
- B. 100
- C. 350
- D. 600

12. Which component compensates for variations in rotor brake system line pressure caused by changes in temperature?

- A. Pressure switch
- B. Relief valve
- C. Compensator unit
- D. Accumulator

11.-C For starting, the minimum pressure is 320 psi. (Refer to page 7)

12.-D The air pressure in the accumulator compensates for the pressure variations. (Refer to page 9)

TRANSMISSION SYSTEM

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the main gear box.
2. Summarize the operation of the main gear box lubrication system.
3. Explain the main gear box indicating and warning systems.
4. Describe the tail drive shaft assembly.
5. Explain the intermediate gear box.
6. Summarize the operation of the tail gear box.
7. Describe the tail rotor head and blades.

The transmission system consists of the main gear box, tail drive shaft, intermediate gear box, tail gear box, and tail rotor assembly. The main gear box (figure 18) drives the main rotor head, tail drive shaft, and accessory components. The accessory components, including the main gear box oil pumps, generators, and hydraulic pumps, are driven whenever the auxiliary power unit or rotor head is operating. The tail drive shaft (6) transmits torque to the intermediate gear box (5), where the drive angle is changed, and on to the tail gear box (3), where the drive angle is again changed and rpm reduced to drive the tail rotor. The tail drive shaft also drives the oil cooler and blower. Oil from the main gear box is fed to the oil cooler and blower, cooled, and returned to the gear box for lubrication and cooling purposes. The main gear box also includes freewheel units that balance input from the engines and permit freewheeling of the main rotor head during autorotation.

MAIN GEAR BOX (Figure 18).

The main gear box, on the transmission deck aft of the engines, drives the accessories, supports and drives the main rotor, and provides a power takeoff to drive the tail rotor. Freewheeling units in the input section permit disengagement of the main rotor and tail drive shafts when the relative main rotor rpm exceeds relative

engine rpm during autorotation, at engine shutdown, and during single-engine operation. A thru-shaft, geared to the No. 1 engine, provides a redundancy for driving the accessories. The auxiliary power unit (APU) may be used for operating the main gear box accessories when engines are not operating.

MAIN GEAR BOX LUBRICATION SYSTEM (Figure 19)

The main gear box is lubricated by a self-priming wet sump system. An oil level sight gage is on the lower left side of the main gear box housing. The oil filler tube is above the oil level sight gage. Three oil pumps are mounted on the rear cover of the main gear box. The No. 1 (primary) oil pump and the torque indicator oil pump are mounted on the lower left, and the No. 2 (secondary) oil pump is mounted on the upper right side. The No. 1 and No. 2 oil pumps circulate oil for main gear box lubrication and cooling. The torque indicator oil pump, using the same oil, supplies the oil to the engine torque indicating system. The No. 2 oil pump serves as a backup for the No. 1 pump in event of failure. Output lines from both pumps are connected at a tee through which oil is routed to the oil cooler and lubrication jets. Each pump is equipped with a filter. The torque indicator oil pump is adjustable for pressure. The magnetic chip detector, in the lower housing, is part of the

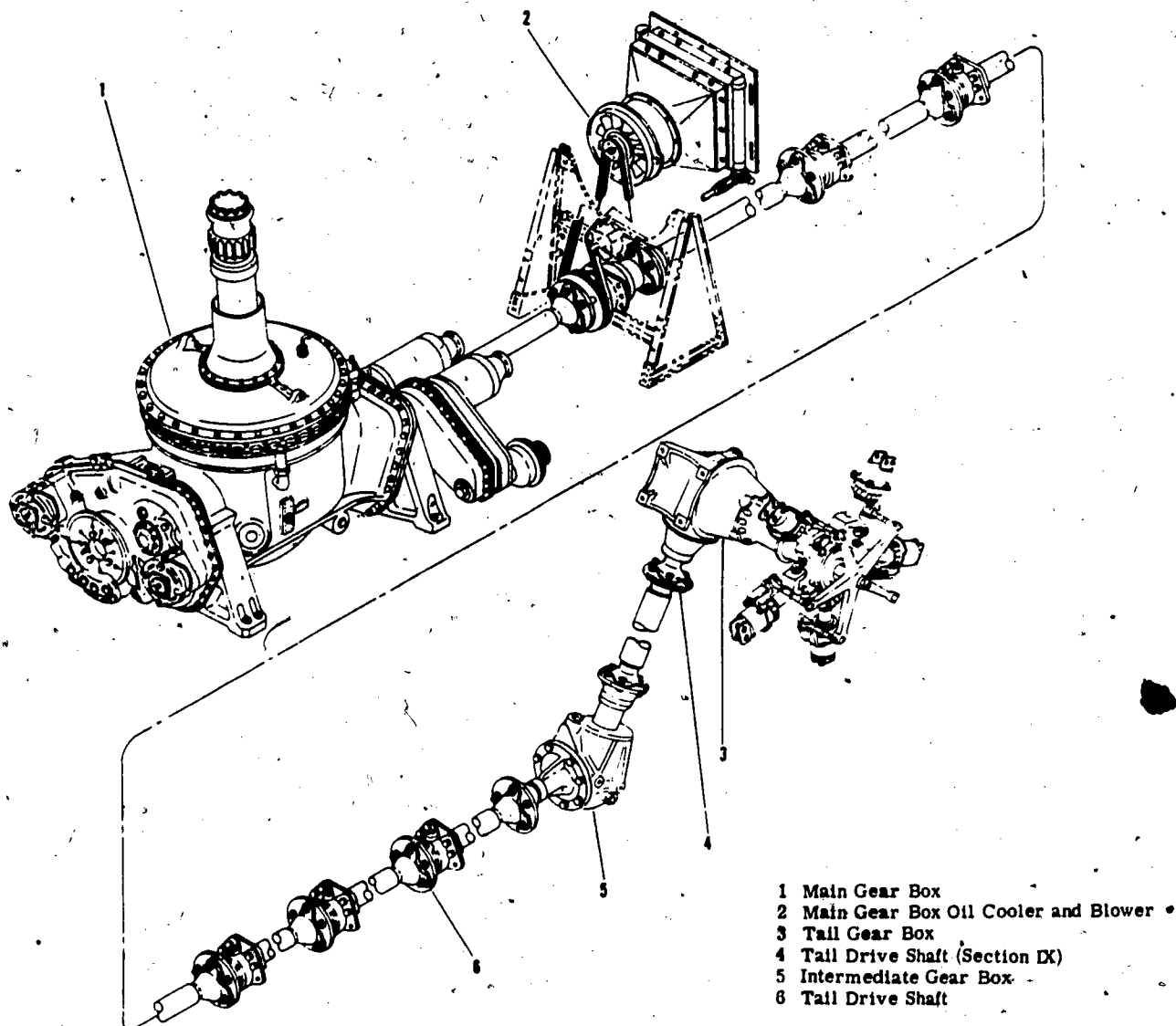


Figure 18. - Transmission system - component location diagram.

chip detector warning system. It may be removed for inspection without draining the oil. A transmitter sends oil pressure readings to the XMSN OIL PRESS indicator on the instrument panel. A temperature bulb, in the lower housing sump, transmits oil temperature readings to the oil temperature indicator. When oil pressure falls below safe limits, the XMSN OIL PRESS light capsule on the caution/advisory panel will illuminate. When oil temperature rises above 121° C. (250° F.), the XMSN OIL HOT light capsule on the caution/advisory panel will illuminate.

AUGMENTED MAIN GEAR BOX OIL SYSTEM (Figure 19)

The augmented main gear box oil system will permit the helicopter to continue operating for approximately 45 minutes in the event of a failure in the main lubrication system. In this event the auxiliary sump which is located at the base of the main gear box, provides an oil supply of approximately 1.5 gallons to lubricate the input sleeve bearings in the high speed section of the main gear box. The torque-meter pump utilizes oil from the auxiliary

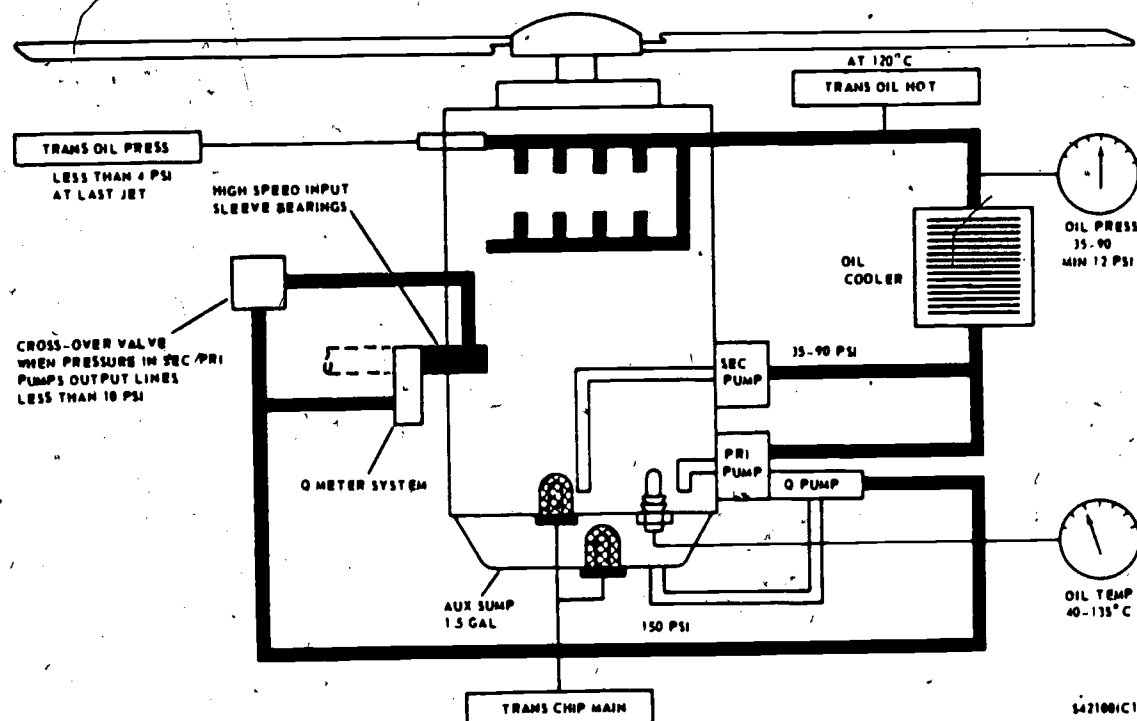


Figure 19. - Main transmission with auxiliary sump.

sump to lubricate these bearings and to supply oil to the torque sensing system. An additional chip detector is installed in the auxiliary sump and illuminates the XMSN CHIP MAIN caution light.

taching parts. It is attached to the main gear box lower cap and prevents large metal particles from entering and causing damage to the No. 2 oil pump. The strainer may be inspected without draining the main gear box.

Oil Pump Screen

A self-sealing pump screen in the lower aft. section of the main gear box lower housing, between the sump and lubricating pump, prevents large metal particles from entering and causing damage to the pump. The screen may be inspected without draining main gear box oil. A temperature bulb is in the center of the screen.

Oil Pump Strainer

The oil pump strainer consists of a strainer, sleeve, retainer, elbow, and at-

MAIN GEAR BOX INDICATING AND WARNING SYSTEMS

Main gear box indicating and warning systems consist of the following: torque indicating system, main gear box oil pressure indicating system, main gear box oil low pressure warning system, main gear box oil temperature indicating system, and main gear box oil hot temperature warning system. Each system operates independently.

Torque Indicating System

The system indicates engine torque by measuring the loads on the gears in the main

gear box. The system consists of a pump, torque sensing mechanism associated with the second-stage helical gear of the main gear box, two pressure transmitters, and dual pointer torque indicators. The pump, in the accessory cover of the main gear box, delivers gear box lubricating oil at 150 psi pressure through external lines to the torque sensing mechanism. The oil is then discharged back into the gear box. Each torque sensing mechanism incorporates a torque-meter valve; sensing chamber, between the torque-meter housing and the piston of the torque sensing mechanism; and an orifice in the piston. The second-stage helical gears produce a thrust proportional to engine torque. Each pressure transmitter is connected to a sensing chamber and to both torque indicators. Operation of the torque indicating system is dependent on the relationship between the pressure within the sensing chamber and the forces exerted on the second-stage helical gear. With engine power applied and the rotor brake released, main rotor head resistance to rotation (anti-torque) bears on the second-stage helical gear, which results in forward displacement of the shaft. Oil from the pump enters the sensing chamber through the balancing valve and exhausts through the orifice. Sensing chamber pressure is determined by the force on the second-stage helical gear which displaces the shaft and the balancing valve, changing the differential in flow between the balancing valve and the orifice. As main rotor blade pitch is increased, the increased helical gear thrust opens the balancing valve further, and sensing chamber pressure increases. As pitch is decreased, the balancing valve closes and fluid exhausts through the orifice. Thus, sensing chamber pressures are directly proportional to engine torque. Sensing chamber pressure is measured by the transmitter and displayed on the torque indicators as percent of available torque. A hydraulic pressure gage tester may be used for checking the indicating system for accuracy. The torque indicators on the instrument panel have dial ranges from 0 to 150 percent torque. The No. 1 pointer represents engine torque for the No. 1 (left) engine.

Main Gear Box Oil Low Pressure Warning System

The system consists of a pressure switch on the lower right side of the input cover and XMSN OIL PRESS light capsule on

the caution/advisory panel. When oil pressure in the main gear box drops to approximately 4 psi, the pressure switch closes, causing the light capsule to illuminate.

Main Gear Box Oil Temperature Indicating System

The system consists of an indicator and a temperature bulb. Mounted at the lower center of the instrument panel, the XMSN OIL TEMP indicator registers main gear box outlet oil temperature in degrees Centigrade. The indicator dial has a range of -50° to 180° C. and is divided into graduations of 5° C.

Main Gear Box Oil Temperature Hot Warning System

The system consists of a temperature control unit, relay, and XMSN OIL HOT light capsule on the caution/advisory panel. The control unit is at the left rear of the main gear box in the oil pressure line between the oil cooler blower and main gear box. The relay is on the relay panel secured to the cockpit bulkhead. When oil temperature exceeds 121° C. (25° F.), actuation of the control unit occurs, closing the relay contacts and illuminating the XMSN OIL HOT light capsule. This provides the pilot with a visual indication that a malfunction is occurring. When the temperature drops below 120° C. (250° F.), the light capsule will go out.

MAIN GEAR BOX OIL COOLER AND BLOWER (Figures 20 and 21)

The oil cooler and blower in the aft main rotor fairing consists of a cooler, radiator, duct, and blower. The cooler is belt driven by the tail drive shaft and forces air through the radiator (12, figure 20). Hot oil from the main gear box sump is forced into the radiator. If the temperature of the oil is less than 70° C. (158° F.) it is bypassed to the return line by a thermostatic regulator. Oil returning from the radiator or the bypass is forced through the lubrication jets in the gear box.

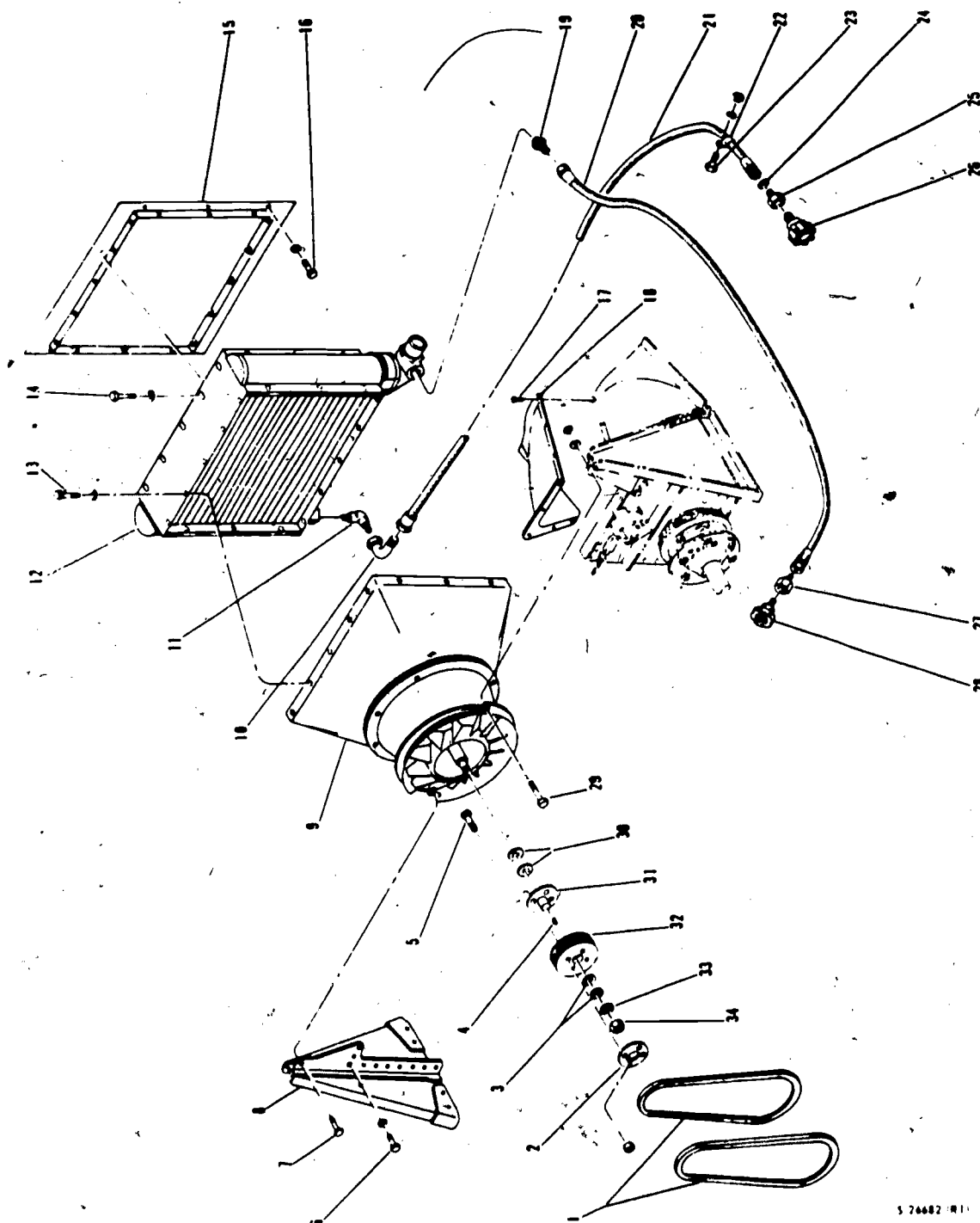


Figure 20. - Main gear box oil cooler and blower - removal/installation.

MULTIPLE-DISC COUPLING (Figure 22)

On helicopters modified by T.C.T.O.
1H-3-563 and on CG 1476 and subsequent,

a dynamically balanced coupling joins the main gear box tail takeoff flange to the tail drive shaft. This coupling consists of three flexible steel disc assemblies, a spherical bearing, four flanges, and attaching bolts, washers, isolators, and nuts.

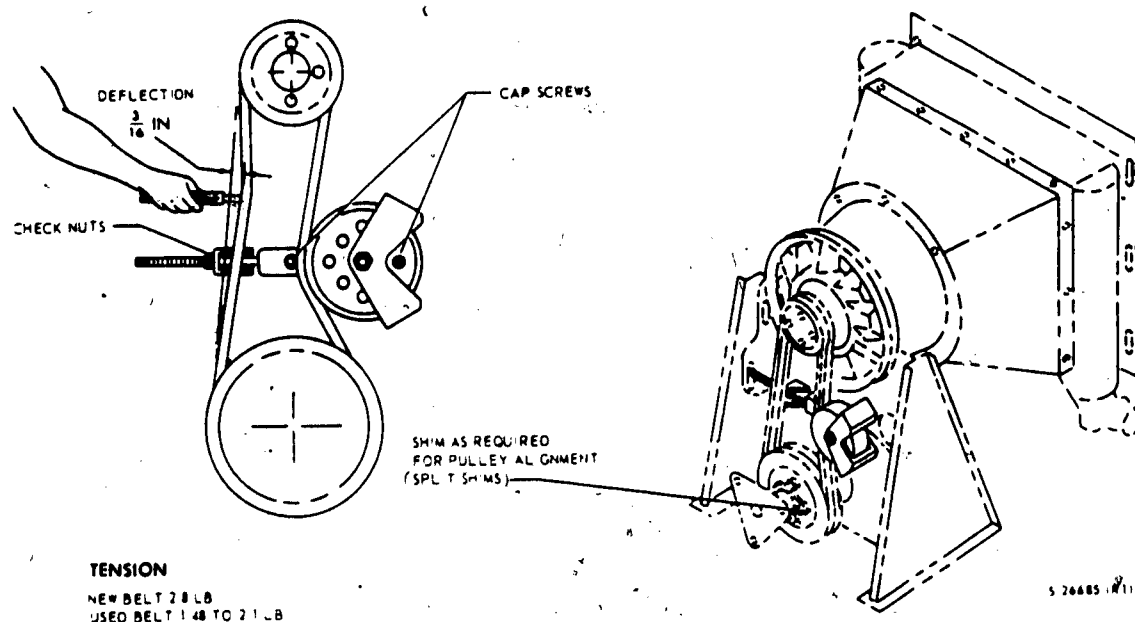


Figure 21. - Pulley belts - alignment and tension.

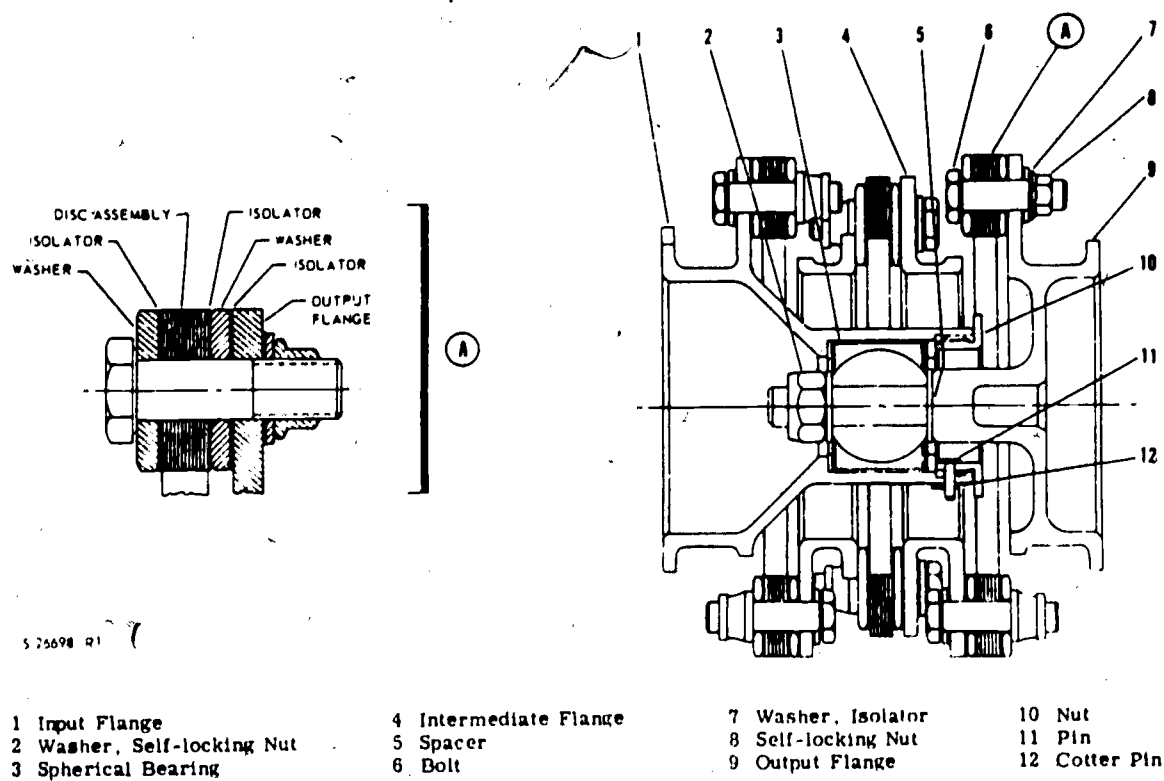
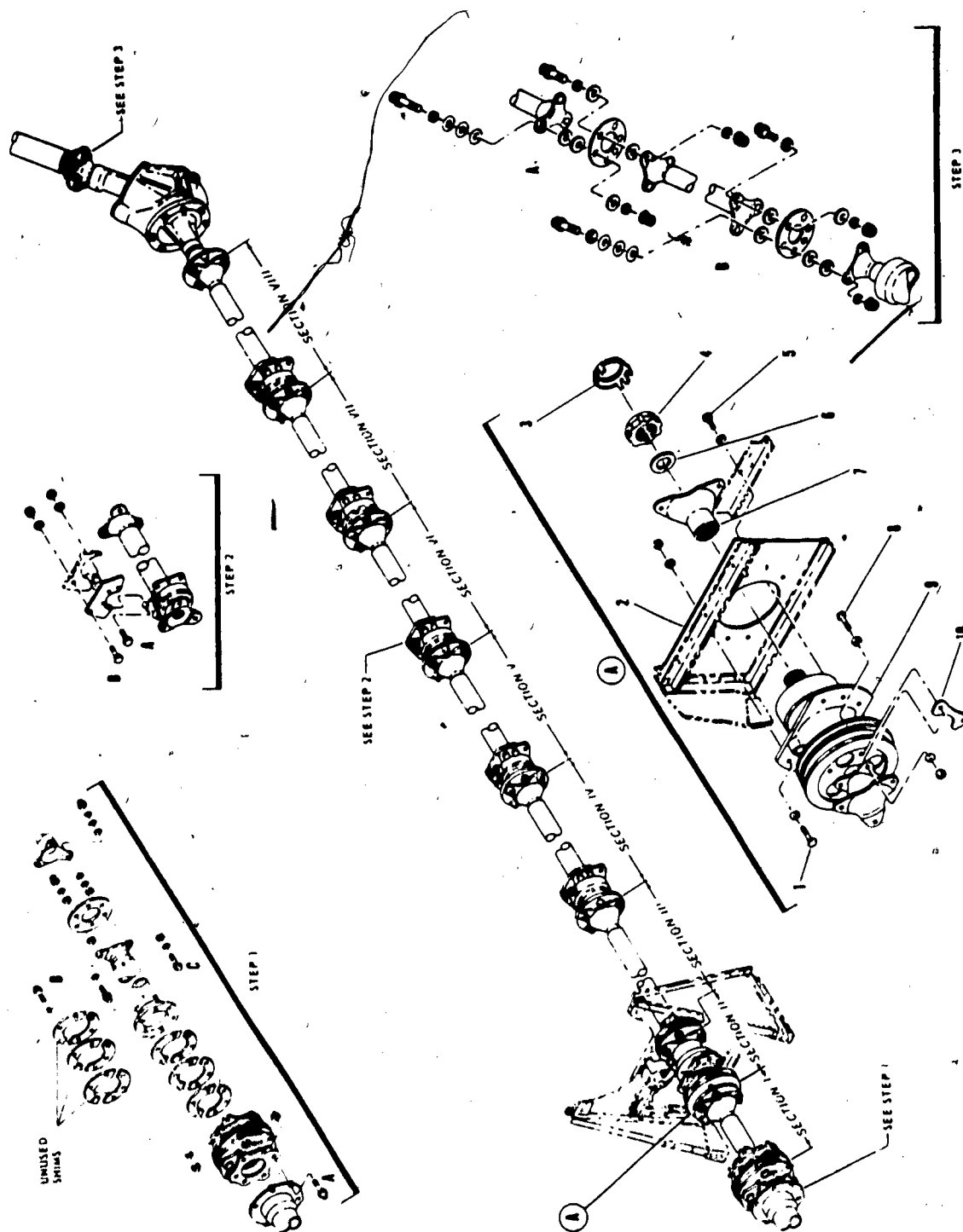


Figure 22. - Multiple disc coupling.



TAIL DRIVE SHAFT
(Figure 23)

The tail drive shaft extends from the tail takeoff coupling flange at the rear

cover of the main gear box to the intermediate gear box, and from the intermediate gear box to the tail gear box. The primary purpose of the tail drive shaft is to transmit engine torque to the tail rotor. The tail drive shaft also transmits power

Figure 23. - Tail drive shaft.

through a drive pulley to operate the main gear box oil cooler and blower fan. The tail rotor drive shaft is made up of nine separate dynamically balanced shafts. The shafts are joined by flexible steel discs and a dynamically balanced flexible diaphragm coupling or a multiple-disc coupling that is joined to the front end of the section I tail drive shaft.

The shaft is suspended at five points in viscous damped bearings and is additionally supported at section II in a double ball-bearing housing. The bearing housings are mounted on support plates bolted to fuselage support brackets. Section I of the tail drive shaft consists of a shaft flanged at both ends with a special disc attached to the flange that connects to section II. Section II consists of a shaft, flanged at the forward end. The oil cooler drive pulley is mounted on the shaft, and the shaft rotates on two ball bearings mounted in an aluminum housing. Included also in section II is a separate coupling flange which is splined to the aft end secured by a washer, lock washer, and nut. Section III consists of a shaft flanged at both ends with a special disc attached to each flange with bolts, washers, and nuts. Sections IV, V, VI, VII, and VIII are flanged at both ends. A special disc is secured to the aft flange of each section with bolts, washers, and nuts, and a viscous mounted bearing is positioned adjacent to the forward flange of each shaft. Section IX extends from the intermediate gear box to the tail gear box. A special disc is attached to the flange at each end with bolts, washers, and nuts. Bolts, washers, nuts, and shims are used for joining.

INTERMEDIATE GEAR BOX (Figure 24)

The intermediate gear box, on brackets at the base of the pylon, consists of an input housing and gear, center housing, and output housing and gear. Torque from tail drive shaft section VIII is transmitted to section IX through a bevel gear in the input housing and a bevel gear in the output housing, changing directional drive approximately 65 degrees. The center housing incorporates an oil level sight gage on the left side, filler plugs at the top and at the left rear, and a magnetic chip detector drain plug at the bottom. The magnetic chip detector plug is part of the chip detector

warning system which provides an indication on the caution/advisory panel should metal particles accumulate. The intermediate gear box is splash lubricated and air cooled.

TAIL GEAR BOX (Figures 25 and 26)

The tail gear box, mounted at the top of the pylon, serves as the point of attachment for the tail rotor head, changes the direction of drive 90 degrees, and reduces tail rotor rpm. A control rod, controlled by the tail rotor flight controls, operates the pitch change beam. The pitch change beam is connected to the sleeve of each tail rotor blade through pitch change links to change the pitch of blades. The gear box is splash-lubricated. A magnetic chip detector is installed in the bottom of the input housing and is part of the chip detector warning system which provides an indication on the caution/advisory panel should metal particles accumulate on the plug. Access to the tail gear box is gained by removing the tail gear box access fairing at the top of the pylon.

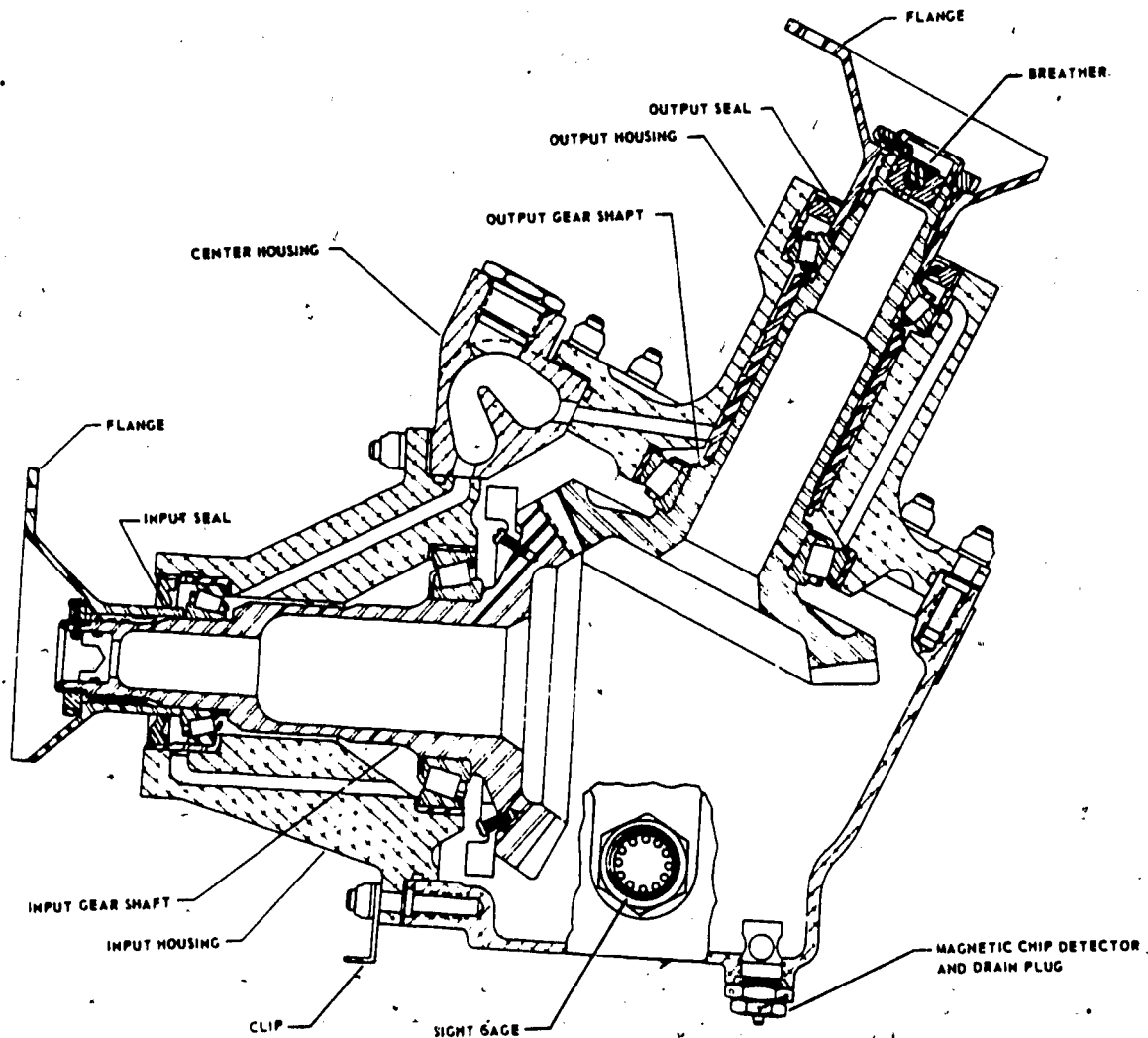
CHIP DETECTOR SYSTEM

The system consists of three magnetic chip detector plugs, three relays, and MAIN, INTMED, and TAIL XMSN CHIP light capsules on the caution/advisory panel. Metal chips accumulating on the chip detector plugs in the gear boxes close the circuit to the appropriate relay and cause the light capsule to illuminate. The light capsules provide the pilot and copilot with a visual indication when chips are present in the gear boxes. When the relays are energized, a holding circuit is created which keeps the light capsules illuminated until the chips are cleaned off the magnetic chip detector plugs and the holding circuit is de-energized.

TAIL ROTOR ASSEMBLY

TAIL ROTOR BLADES

Five tail rotor blades are installed on the tail rotor head. The root end permits



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Figure 24. - Intermediate gear box - cross-sectional view.

the attachment of the blades to the tail rotor head spindles, and the abrasion strip protects the leading edge of the blade from sand, dust, and adverse weather conditions. Skin is wrapped completely around the spar, and the trailing edge cap is installed over the edges of the skin at the trailing edge of the blade. The tip cap is riveted to the blade out-board end. Each blade is balanced statically and dynamically within tolerances that permit individual replacement of blades.

TAIL ROTOR HEAD (Figures 26 and 27)

The self-lubricated tail rotor head, at the top left side of the pylon, produces anti-torque forces which may be varied by the pilot to control flight heading of the helicopter. The tail rotor head is driven by the tail gear box. Blade pitch is changed through the pitch change shaft that moves through the output gear shaft of the tail gear box. As the shaft moves outward from the gear box, pitch of the blades is decreased (leading edge away from pylon). As the shaft moves in toward the gear box, pitch of the blades is increased.

The pitch change beam is connected by links to the forked brackets of the

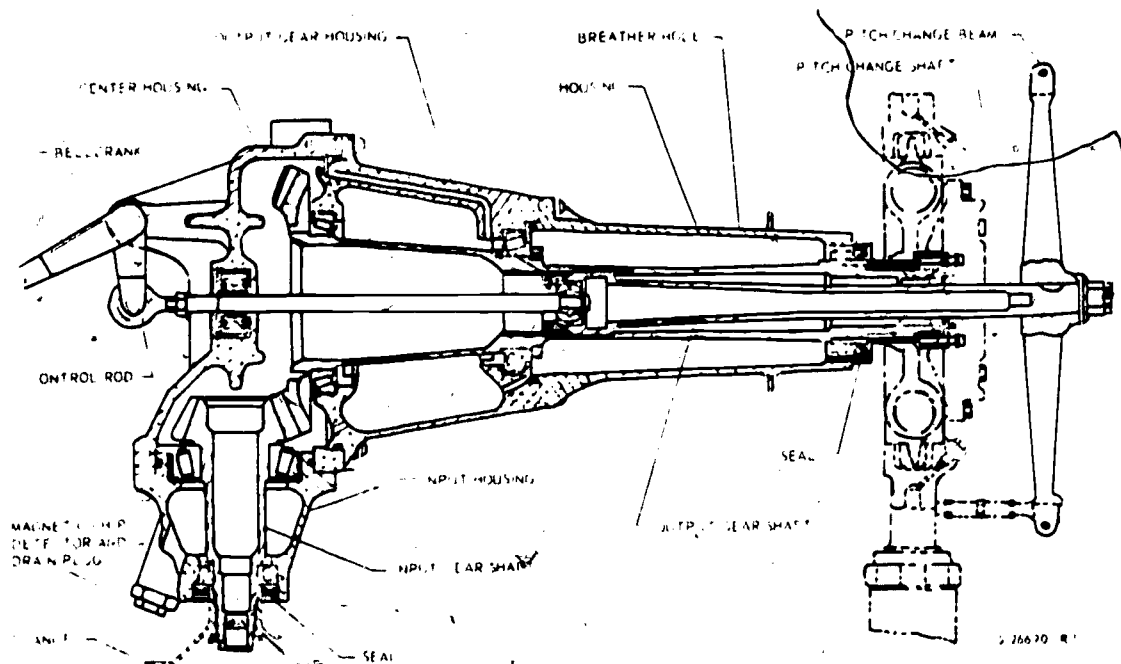


Figure 25. - Tail gear box - cross-sectional view.

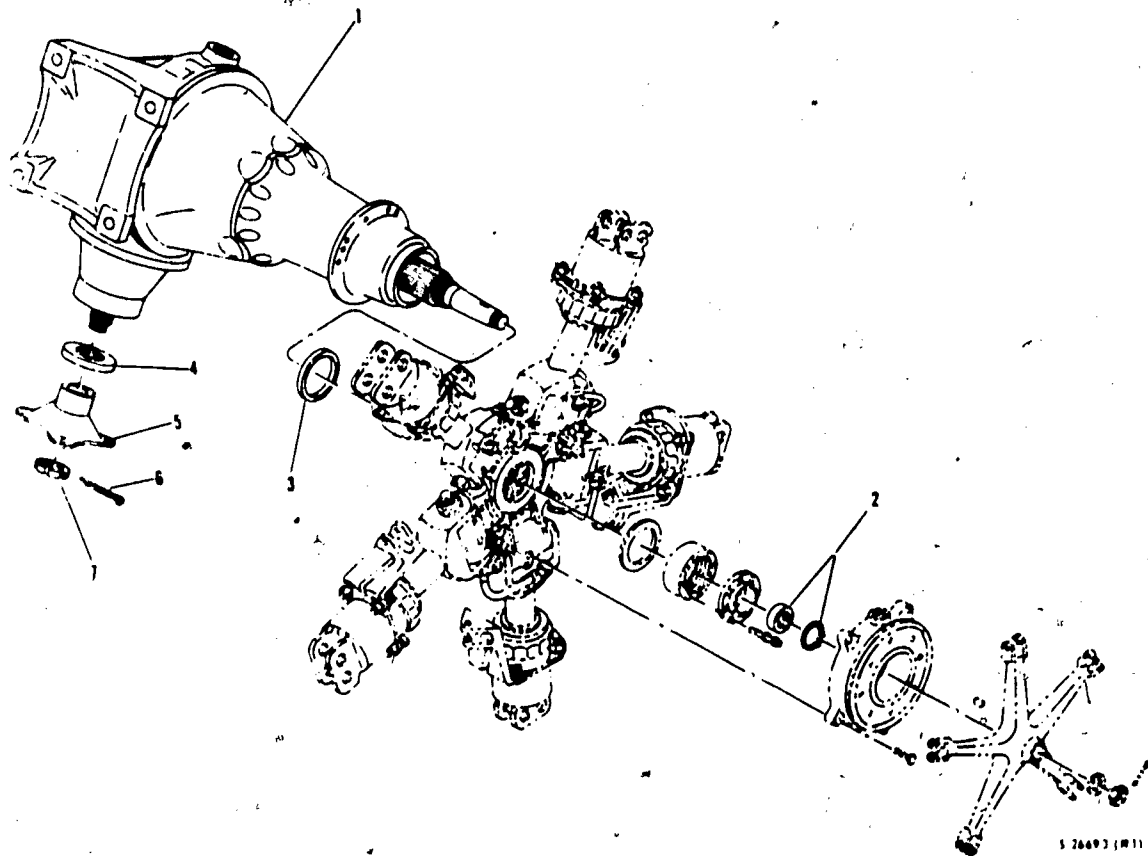
sleeves. The five flapping spindles permit flapping of the blades to a maximum of 10 degrees in each direction. The hinge pins and the spindle bearings are lubricated centrifugally by oil from the tail rotor reservoir. The oil passes through drilled passages in the bolts securing the reservoir into the head, and into the hub and lubricates the hinge pins. It then passes through tubes secured to the hub, and into the spindles and lubricates the stock bearings. Balancing weights are bolted to the sleeve-spindle flanges to prevent vibrations during tail rotor operation.

NOTE:

Lip-type seals used in tail rotor components are subject to static seepage. After installation they may require a 5-hour break-in period, which can be accrued before the seals seat.

TAIL ROTOR RESERVOIR
(Figures 27 and 28.)

The reservoir on the tail rotor head serves as a storage tank for lubricating oil for the hinge pins and the spindle stack bearings. The reservoir is filled or drained through the bleed plug.



1 Tail Gear Box
2 Seal, Lock Ring
3 Seal

4 Seal
5 Flange

6 Cotter Pin
7 Nut

Figure 26. - Tail gear box.

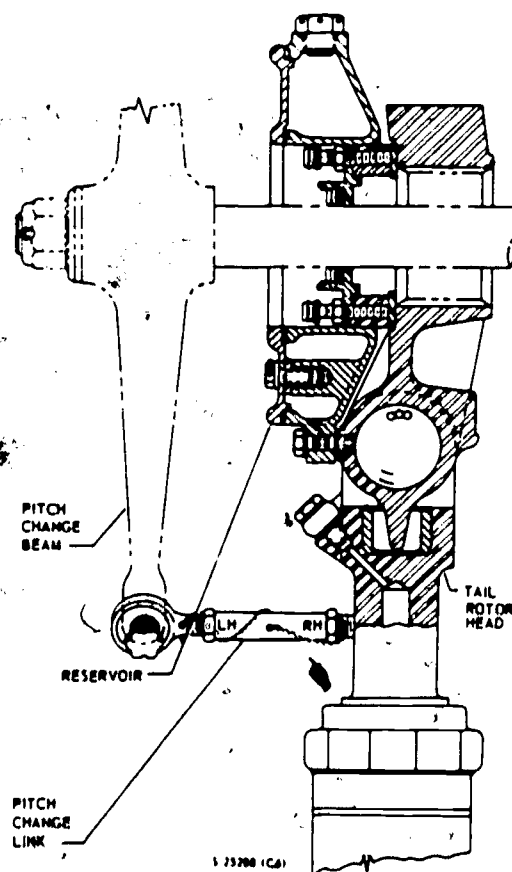


Figure 27. - Tail rotor head - cross-sectional view.

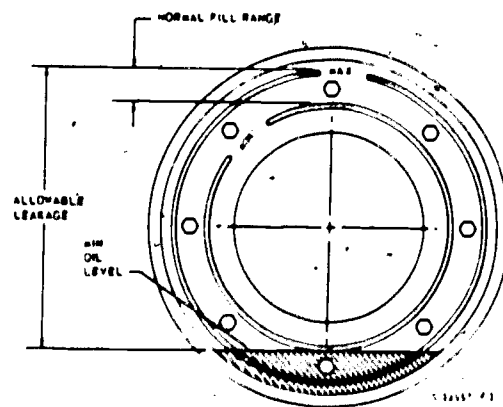


Figure 28. - Tail rotor reservoir.

REVIEW

This section covering the transmission system has given you the information needed to complete your syllabus and preflight the aircraft.

(Now answer the following review questions.)

13. Main engine output is balanced by the _____ in the main gear box. 13.-D (Refer to page 17)

- A. main rotor shaft
- B. planetary gear
- C. ring gear
- D. input freewheel units

14. To check the main gear box oil level, you should use a/an _____. 14.-C (Refer to page 17)

- A. oil quantity gage in the cockpit
- B. oil quantity gage on the gear box
- C. sight gage on the lower left side of the main gear box housing
- D. sight gage on the lower right side of the main gear box housing

15. What is the purpose of the No. 2 (secondary) main gear box lube pump? 15.-C (Refer to page 17)

- A. Double the oil pressure
- B. Double the oil flow volume
- C. Serve as a backup if the No. 1 pump fails
- D. Provide oil pressure for the torque indicating system

16. Which main gear box pump has provisions for adjusting the outlet pressure? 16.-C (Refer to page 17)

- A. No. 1 (primary)
- B. No. 2 (secondary)
- C. Torque indicating
- D. Scavenge

17. The augmented main gear box oil system will permit the helicopter to continue operating for approximately _____ minutes if there is a failure in the main lubrication system. 17.-C (Refer to page 18)

- A. 15
- B. 30
- C. 45
- D. 60

18. The oil pump strainer is installed in the main gear box lubrication system to prevent _____ from damaging the oil pump.

- A. large metal particles
- B. small metal particles
- C. micron particles
- D. water

19. Oil pressure to the cockpit indicator is taken from what point in the main gear box oil system?

- A. Before the oil enters the main gear box
- B. Before the oil enters the pressure relief valve
- C. Before the oil enters the oil cooler
- D. After the oil passes through the torque meter sensing unit

20. Operation of the torque indicating system is dependent on a relationship between what two factors?

- A. Sensing chamber pressure and forces exerted on the main bevel gear of the main gear box
- B. Main gear box oil pressure and forces exerted on the main gear box input bevel gear
- C. Forces exerted on the main gear box second-stage spur gear and main system oil pressure
- D. Forces exerted on the main gear box second-stage helical gear and sensing chamber pressure

21. The XMSN OIL HOT light capsule on the caution/advisory panel will illuminate if the main gear box oil temperature rises above _____.

- A. 100° C.
- B. 121° C.
- C. 150° C.
- D. 250° C.

22. A drive pulley is mounted on section _____ of the tail drive shaft.

- A. I
- B. II
- C. III
- D. IV

18.-A (Refer to page 19)

19.-A (Refer to page 19)

20.-D (Refer to page 20)

21.-B (Refer to page 20)

22.-B (Refer to page 24)

23. What is/are the purpose(s) of the intermediate gear box?

1. Change the angle of drive
2. Reduce tail rotor rpm
3. Reduce tail rotor drive shaft rpm
4. Increase tail rotor drive shaft rpm

- A. 1 only
- B. 1 and 2 only
- C. 2 and 3 only
- D. 1, 2, and 4

23.-A (Refer to page 24)

24. The tail blade pitch is changed by movement of the _____.

- A. output gear shaft
- B. pitch change beam
- C. counterweight assembly
- D. flapping spindles

24.-B (Refer to page 24)

25. Which component is installed on a tail rotor blade assembly by rivets?

- A. Skin
- B. Tip Cap
- C. Spindle
- D. ~~Sleeve~~

25.-B (Refer to page 25)

26. The tail rotor blades are allowed to flap a MAXIMUM of _____ degrees in each direction.

- A. 5
- B. 7
- C. 10
- D. 13

26.-C (Refer to page 26)

FLIGHT CONTROL SYSTEM

OBJECTIVES

When you complete this section, you will be able to:

1. Summarize the operation of the main rotor flight control system.
2. Describe the tail rotor flight control system.
3. Describe the primary hydraulic system.
4. Explain the purpose of the primary hydraulic system components and state their location.
5. Summarize the operation of the auxiliary hydraulic system.
6. Explain the purpose of the auxiliary hydraulic system components and state their location.

GENERAL DESCRIPTION

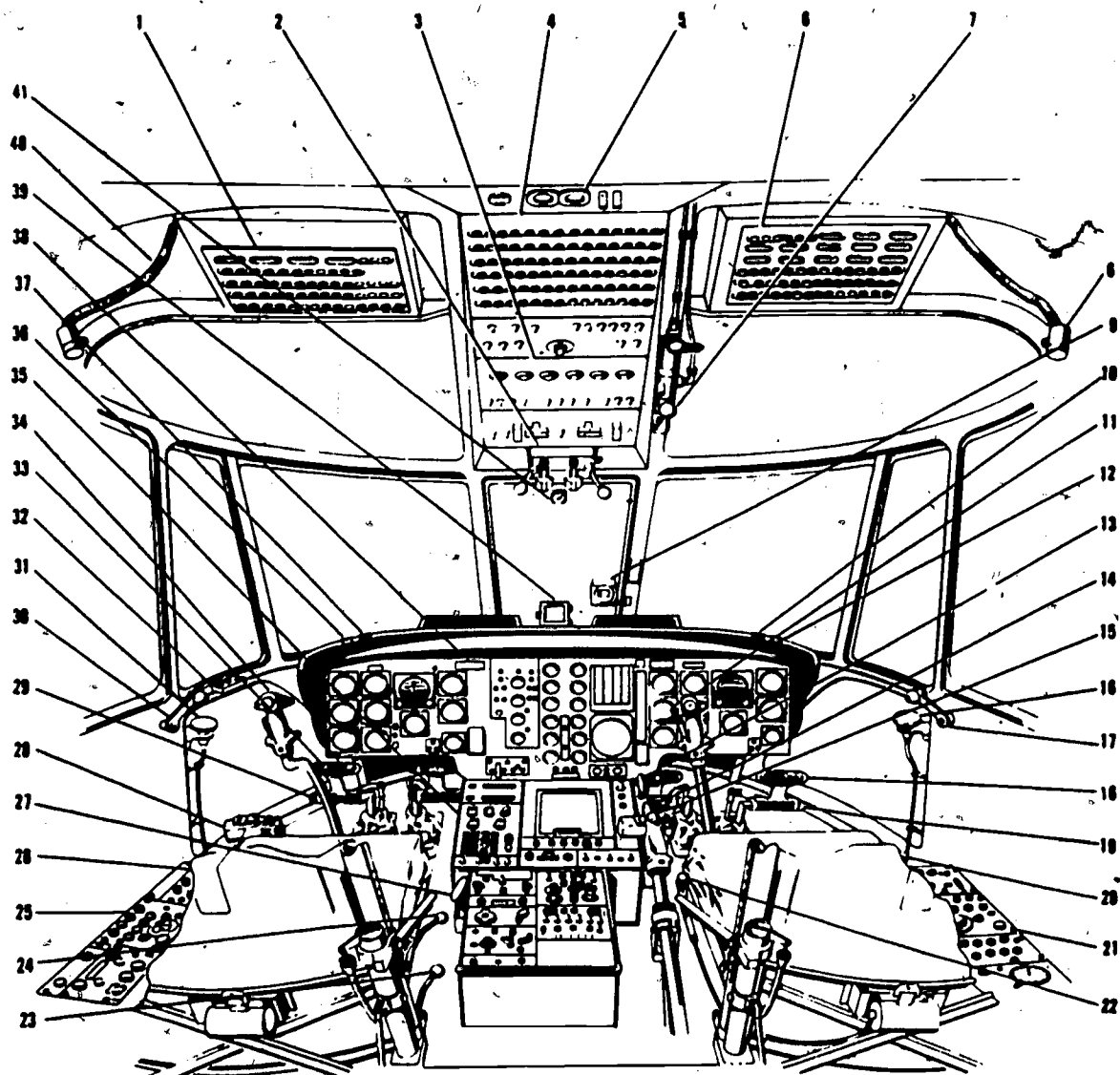
Figures 29 and 30 illustrate the flight control system, which consists of two cyclic control sticks (figure 29, items 11 and 34), two collective control sticks (15 and 28), four directional control pedals (19 and 29), an auxiliary servocylinder, a mixing unit, three primary servocylinders, and mechanical linkage. The cyclic control system controls forward, aft, and lateral helicopter movements; the collective control system controls vertical helicopter movements; and the directional control system controls helicopter heading. Movement of the cyclic or collective control sticks is transmitted by mechanical linkage to the hydraulically actuated auxiliary servocylinder for a power boost, through the mixing unit for coordination with directional control movement, and through the hydraulically actuated primary servocylinders to the main rotor head where blade pitch is changed. Movement of the directional control pedals is transmitted through the mixing unit to the tail rotor by control rods and cables. Flight may also be controlled automatically through the auxiliary servocylinder under signals from the automatic flight control system (AFCS). In addition, a fine degree of cyclic control may be obtained through the auxiliary servocylinder under signals from the stick trim system. Hydraulic power for the system is supplied by the primary and auxiliary hydraulic systems.

MAIN ROTOR FLIGHT CONTROLS
(Figure 30)

The main rotor flight controls consist of the cyclic control system and the collective control system. The cyclic control system provides the means of controlling forward, lateral, and aft movement of the helicopter. Cyclic control stick movements, through mechanical linkage, the auxiliary servocylinder, the primary servocylinders and main rotor head swashplate, cause the blades to change pitch individually, relative to their position on the path of rotation. This will cause the helicopter to move in the direction the cyclic stick is moved. The collective control system controls vertical movement of the helicopter. Collective control stick movements, through mechanical linkage, auxiliary servocylinder, and primary servocylinders, raise or lower the swashplate independently of the cyclic position of the swashplate. This causes blade pitch angles to change simultaneously regardless of their relative position in the path of rotation. The pedals control tail rotor blade angles, and the mixing unit compensates for changes in torque exerted by changing the pitch of the main rotor blades to maintain the same helicopter heading.

CYCLIC CONTROL SYSTEM
(Figures 29, 30, and 31)

The cyclic control system controls forward, lateral, and aft movement of the



- | | |
|--|---|
| 1. COPILOT'S CIRCUIT BREAKER PANEL | 22. PILOT'S SHOULDER HARNESS LOCK LEVER |
| 2. ENGINE CONTROL QUADRANT | 23. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER |
| 3. OVERHEAD SWITCH PANEL | 24. COPILOT'S SEAT FORWARD AND AFT ADJUSTMENT LEVER |
| 4. OVERHEAD DC CIRCUIT BREAKER PANEL | 25. COPILOT'S CONSOLE |
| 5. PILOT'S COMPARTMENT DOME LIGHT | 26. COPILOT'S SEAT |
| 6. PILOT'S CIRCUIT BREAKER PANEL | 27. ALTERNATE LANDING GEAR HANDLE |
| 7. ROTOR BRAKE LEVER | 28. COPILOT'S COLLECTIVE PITCH LEVER |
| 8. PILOT'S MAP LIGHT | 29. COPILOT'S TAIL ROTOR PEDALS |
| 9. STANDBY COMPASS | 30. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE |
| 10. FIRE WARNING LIGHT | 31. COPILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB |
| 11. PILOT'S CYCLIC STICK | 32. LDC LTS AND REMOTE ICS CONTROL PANEL |
| 12. MASTER CAUTION LIGHT | 33. COPILOT'S TOE BRAKES |
| 13. PARKING BRAKE HANDLE | 34. COPILOT'S CYCLIC STICK |
| 14. NOSE WHEEL LOCK HANDLE | 35. COCKPIT CONSOLE |
| 15. PILOT'S COLLECTIVE PITCH LEVER | 36. FIRE WARNING LIGHT |
| 16. PILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB | 37. MASTER CAUTION LIGHT |
| 17. PILOT'S WINDOW EMERGENCY RELEASE HANDLE | 38. INSTRUMENT PANEL |
| 18. PILOT'S TOE BRAKES | 39. SCROLL CHECK LIST |
| 19. PILOT'S TAIL ROTOR PEDALS | 40. COPILOT MAP LIGHT |
| 20. PILOT'S SEAT | 41. FREE AIR TEMPERATURE GAGE |
| 21. PILOT'S CONSOLE | |

S 8577 (C4)

Figure 29. - Cockpit arrangement.

helicopter. Movement of the pilot's or co-pilot's cyclic control stick is transmitted by a series of control rods and bell-cranks through the auxiliary servocylinder, mixing unit, and primary servocylinders to

control movement of the main rotor blades. The cyclic control system also incorporates a stick trim system which hydraulically holds the stick in a selected trim position. During flight, trim movements may be

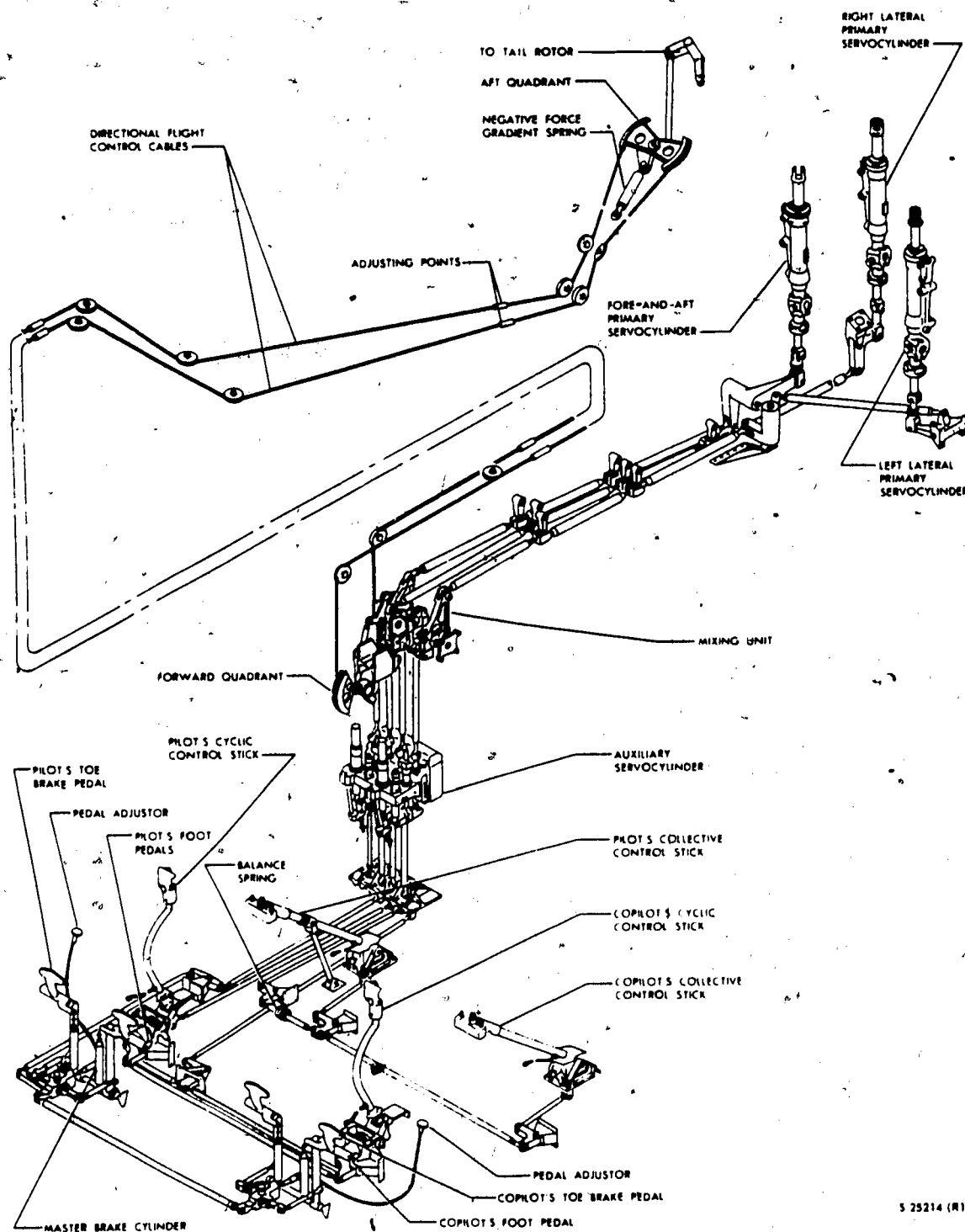


Figure 30. - Flight control system.

controlled manually by a four-way switch on the cyclic stick grip, or overridden for

major control changes by pilot effort on the stick.

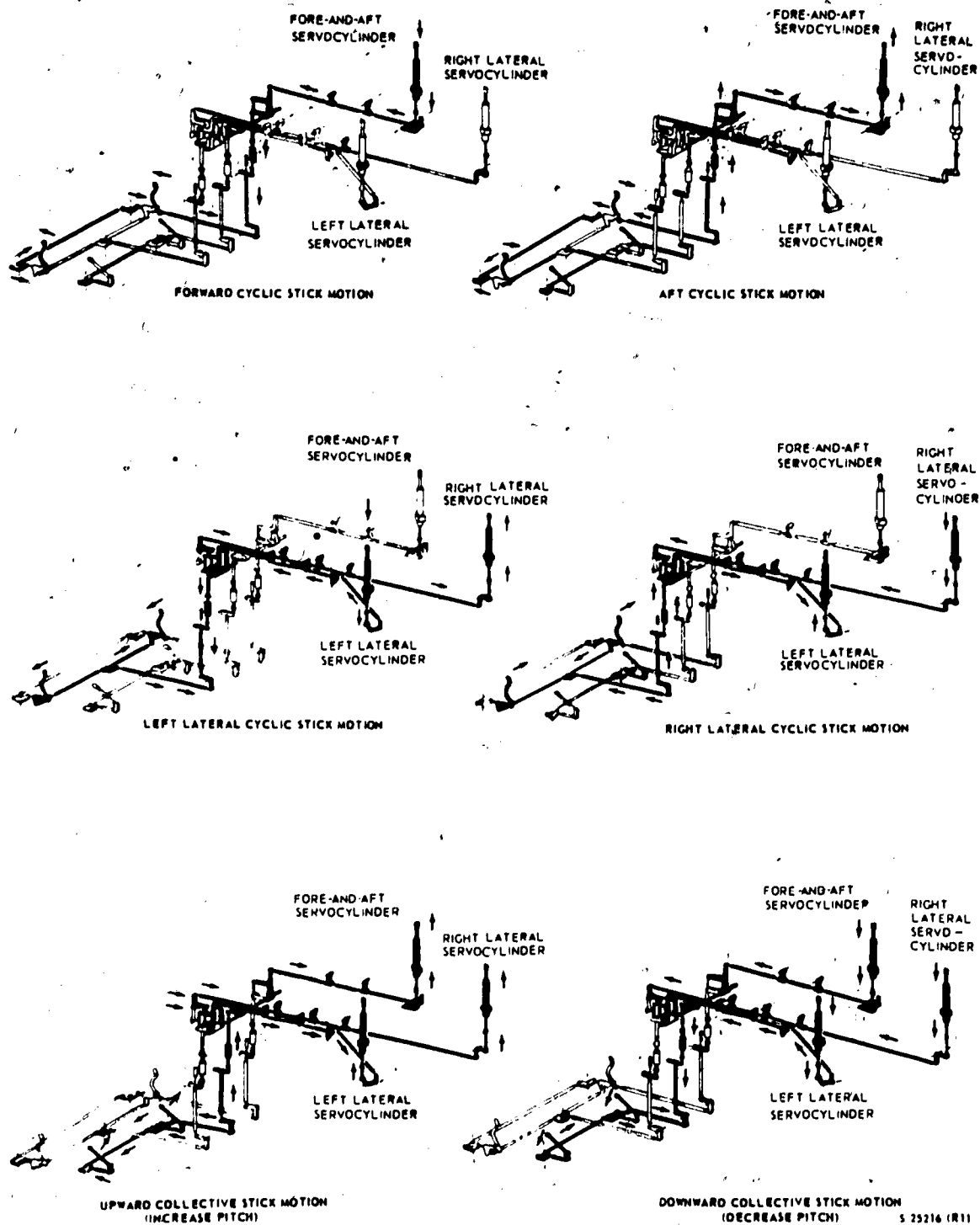
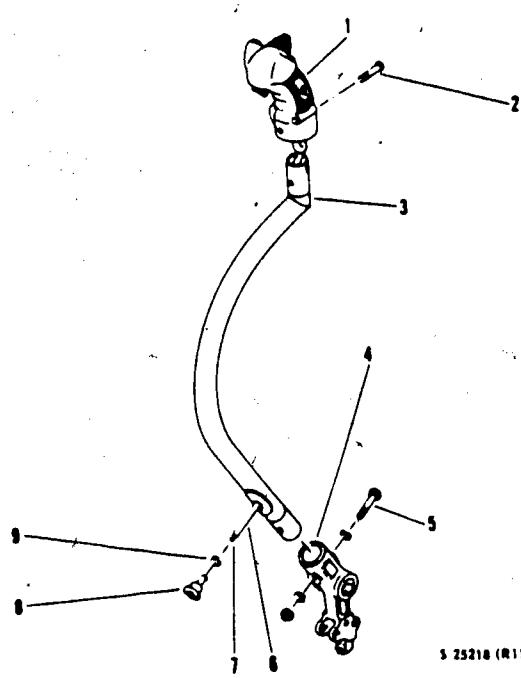


Figure 31. - Main rotor flight control - directional movement.



- | | |
|------------------------|---------------------|
| 1 Grip | 6 Protective Tubing |
| 2 Screw | 7 Wiring |
| 3 Cyclic Control Stick | 8 Plug |
| 4 Socket | 9 Grommet |
| 5 Bolt, Washers, Nut | |

Figure 32. - Cyclic control stick.

Cyclic Control Stick
(Figure 32)

The cyclic control stick for both the pilot and copilot consists basically of a curved aluminum tube (3), socket assembly (4), molded grip (1), and associated wiring. The stick provides an actuating handle that changes the cyclic pitch of the main rotor blade. Moving the cyclic control stick affects the fore-and-aft and lateral movements of the helicopter. The lower end of the stick is fitted with a socket and the upper end with a grip.

Cyclic Control Stick Grip
(Figure 33)

The cyclic control stick grip houses the STICK TRIM, TRIM REL., AFCS RELEASE, I.C.S./RADIO, ENG. ST., and CARGO switches. The grip is contoured to fit the right hand. Both the pilot's and copilot's grips are identical.

Mixing Unit (Figures 30 and 34)

The mixing unit, consisting of a system of bellcranks and linkage mounted on a common shaft, is located inside, near the top of the AFCS controls compartment. The unit coordinates and transfers independent movements of the lateral, forward, aft, and directional (yaw) controls to the primary servocylinders and tail rotor. The mixing unit integrates collective pitch control movements with the lateral, fore-and-aft, and directional systems. This causes the controls to move the primary servocylinders simultaneously in the same direction, and to change the pitch on the tail rotor blades to compensate for changes in pitch of the main rotor blades.

Stick Trim System (Figure 35)

The stick trim system provides a fine degree of control over the cyclic control system during flight. This is accomplished automatically under signals from either STICK TRIM button on the cyclic sticks. Moving the STICK TRIM button forward, aft, left, or right will cause the cyclic stick to move smoothly in that direction. With the STICK TRIM MASTER switch in the ON position, operating the TRIM REL button will disengage the system for complete manual control. Releasing the switch will re-engage the system around the new reference point established by the cyclic stick.

COLLECTIVE CONTROL SYSTEM (Figures 30 and 31)

The collective control system provides vertical control of the helicopter from the pilot's and copilot's collective control sticks through a series of control rods and bellcranks, the auxiliary servocylinder, and mixing unit. At the mixing unit, all movements of the collective stick are transmitted to the primary servocylinders and main rotor swashplate where the pitch of all blades is increased or decreased equally and simultaneously. A balance spring installed on a control rod in the electronic compartment helps to balance the weight of the collective stick when the auxiliary

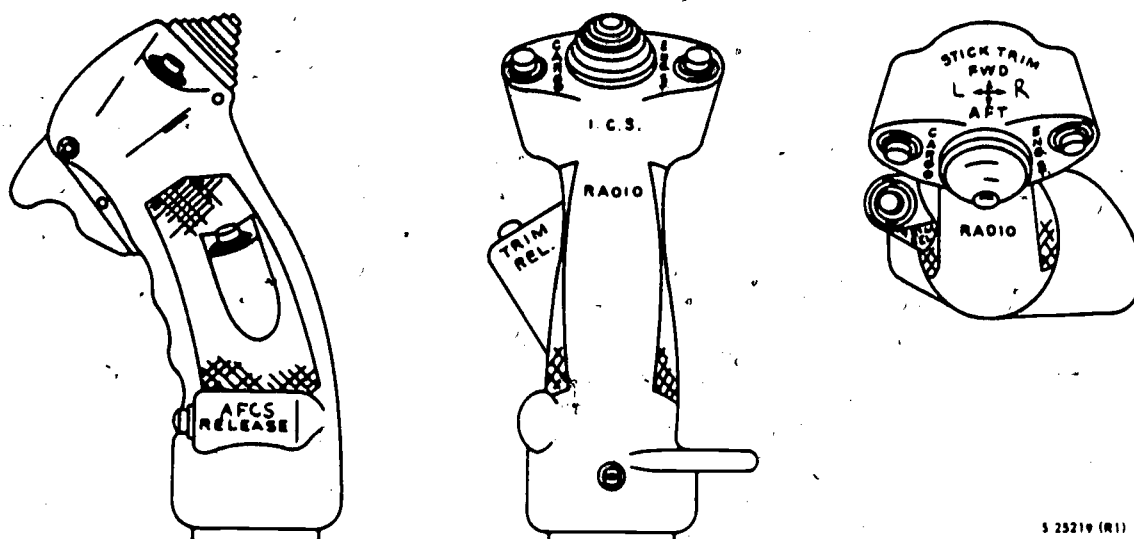


Figure 33. - Cyclic control stick grip.

servo system is off. A collective stick friction lock is located on the pilot's collective control stick. Rotating the serrated handgrip to the stop applies the desired friction to the tube of the collective pitch stick to prevent creeping during flight and to provide feel for the pilot when he is operating the controls. The grip of each collective control stick contains several switches which are labeled for the function they control. (See figure 36.) The AFCS, when in operation, controls operation of the collective control system through the auxiliary servocylinder. The mixing unit compensates for collective control movement to change the pitch of the tail rotor blades.

Collective Control Stick (Figure 37)

The collective control stick is used to change the collective pitch of the main rotor blades. Moving the collective control stick affects the collective lifting pitch of the blades. The lower end of the stick is secured in a socket (11), and the upper end of the stick is fitted with a plastic grip (1) which houses various electrical switches (figure 36.) The wiring for these switches is contained inside the stick. The pilot's collective control stick is equipped with a friction lock mechanism (3-8) which permits the pilot to maintain a desired stick position without holding the stick.

Collective Control Stick Grip (Figure 36)

The pilot's and copilot's collective control stick grips house the CPLR RELEASE., PRI. OFF - AUX. OFF, SLT. TRAIN, ENG + TRIM 1 - 2, HOIST, and BAR. REL. switches. Both grips are contoured to fit the left hand.

TAIL ROTOR FLIGHT CONTROL SYSTEM (Figures 30, 38, and 40.)

The tail rotor flight control system controls pitch of the tail rotor blades, which in turn controls heading of the helicopter. The system consists of foot pedals and an adjustor for the pilot and copilot, and a series of control rods and bellcranks connected to the auxiliary servocylinder, and mixing unit. At the mixing unit, a control rod operates the forward quadrant. From the forward quadrant, cables operate the rear quadrant in the pylon. A control rod from the rear quadrant connects to a control rod and pitch control shaft in the tail gear box. Pedal movements through the mechanical linkage, auxiliary servocylinder, and cables to the tail rotor will change the tail rotor blade angles simultaneously. This causes the helicopter to turn with the main rotor shaft acting as a pivot point. Increasing tail rotor blade pitch (left pedal) will overcome the anti-torque

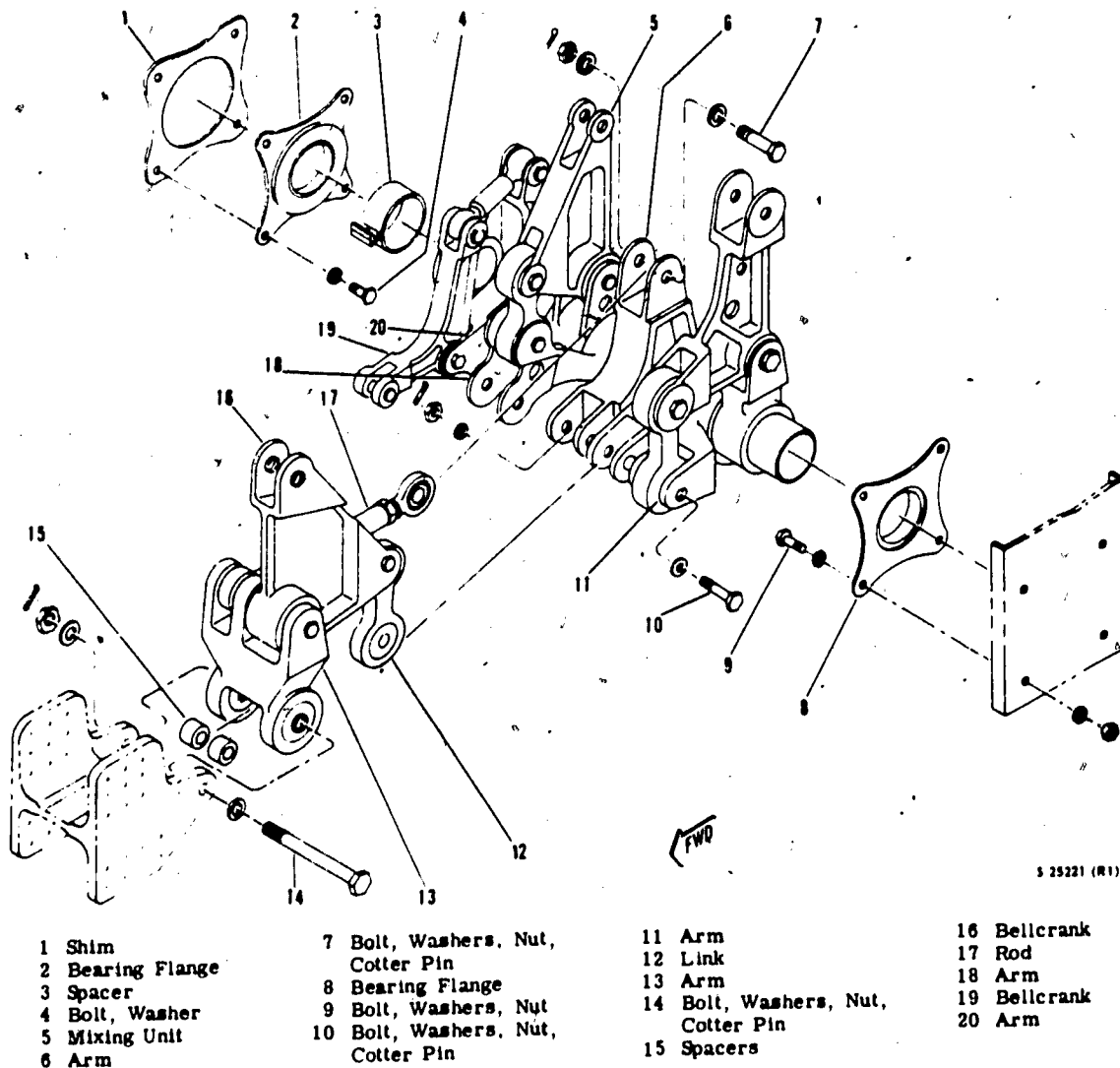


Figure 34. - Mixing unit.

force created by the main rotor, and the helicopter will turn left (pivot in direction of main rotor rotation); decreasing blade pitch will allow the helicopter to turn right (pivot in direction opposite to main rotor rotation.) A hydraulic pedal damper is incorporated in the auxiliary servocylinder to prevent sudden movements of the control pedals from causing rapid changes in blade pitch, which might cause damage to the helicopter. The control pedals can be adjusted for different leg lengths by operating the hand-wheels supported on the fuselage at the left of the copilot and right of the pilot. With the auxiliary hydraulic system off, a negative force gradient spring causes tail rotor feedback

loads. Also, in ground operations, the spring assists pedal movement. The tail rotor flight control system can be operated automatically by the AFCS through the auxiliary servocylinder.

Negative Force Gradient Spring (Figures 30, 38 and 39)

The negative force gradient spring is contained in the housing mounted between a support fitting and the quadrant in the pylon. The housing consists of an adapter, cylinder spring guide, sliding nut, and adjusting nut. An adjustable rod end attaches to the bellcrank.

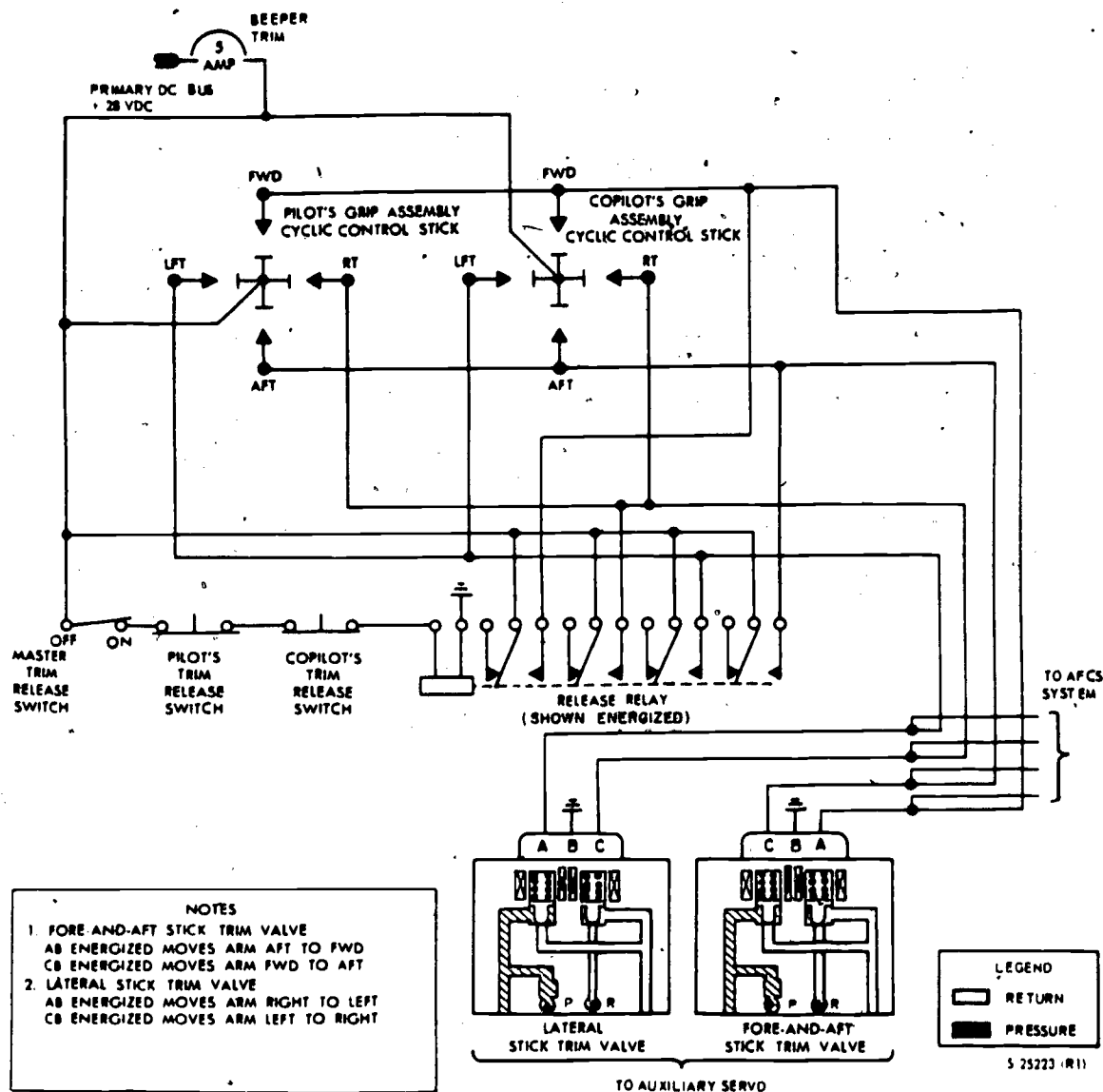


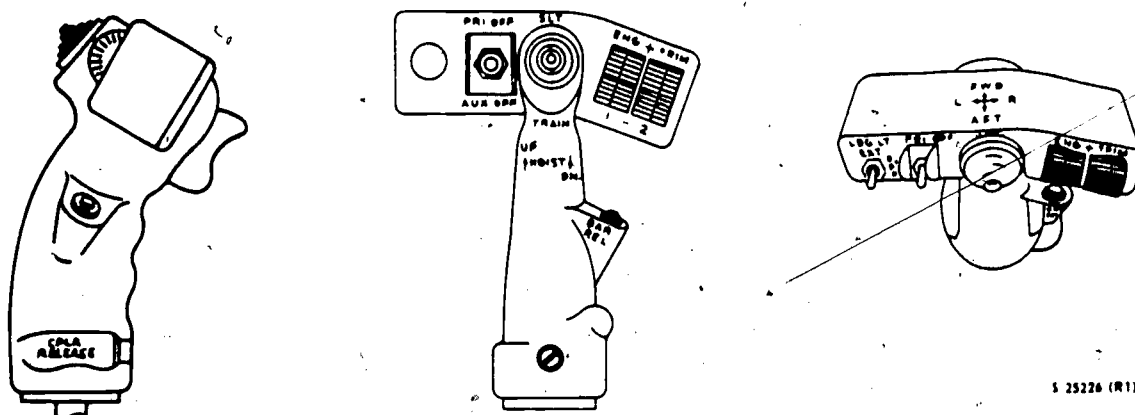
Figure 35. - Stick trim system - schematic diagram.

During flight, the negative force gradient spring cancels feedback loads exerted by the tail rotor when the auxiliary hydraulic system is off. During ground operations, with the tail rotor stationary, the spring extends any pedal movement from neutral to the extreme of the direction moved, provided the auxiliary hydraulic system is off.

Pedal Adjustor

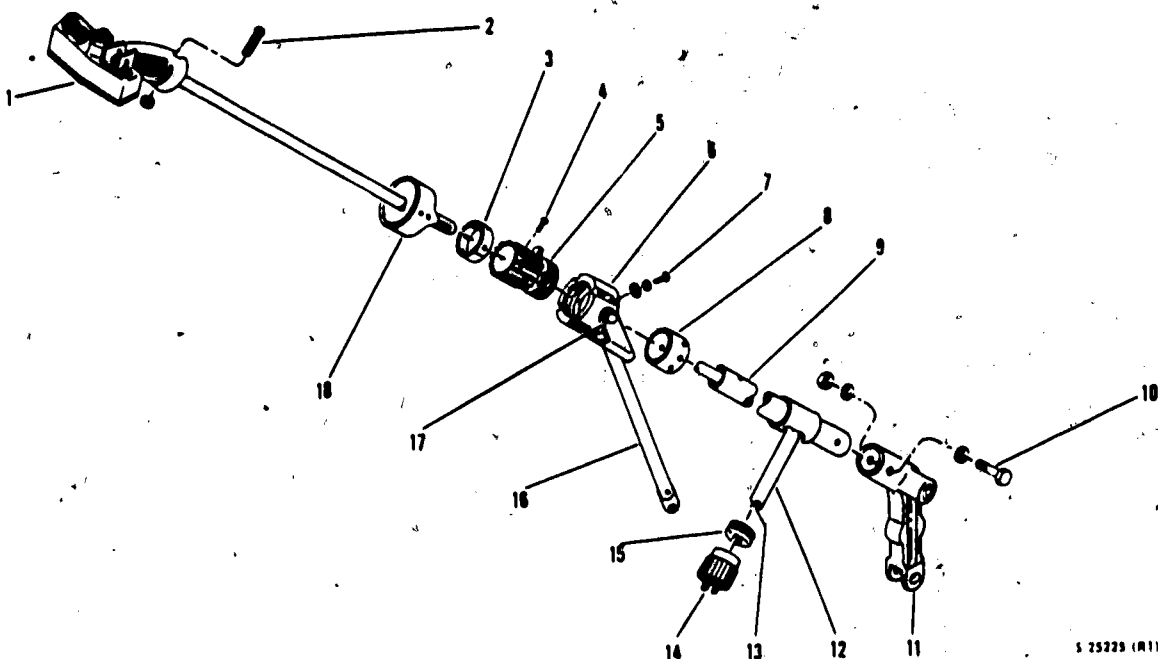
The pilot's and copilot's pedal adjustors are incorporated in the tail rotor

flight controls to position the pedals for increased pilot and copilot comfort. Each pedal adjustor consists of a hand-wheel. (one to the right of the pilot and the other to the left of the copilot), a flexible cable, and the adjustor actuating mechanism in the electronics compartment. Turning the PEDAL ADJUSTOR handwheel FORWARD or AFT increases or decreases the distance from the pedals to the seat. Adjustments should be made with feet away from the pedals to avoid damage to the adjustment cables, striker plates or microswitches.



S 25226 (R1)

Figure 36. - Collective control stick grip.



S 25225 (R1)

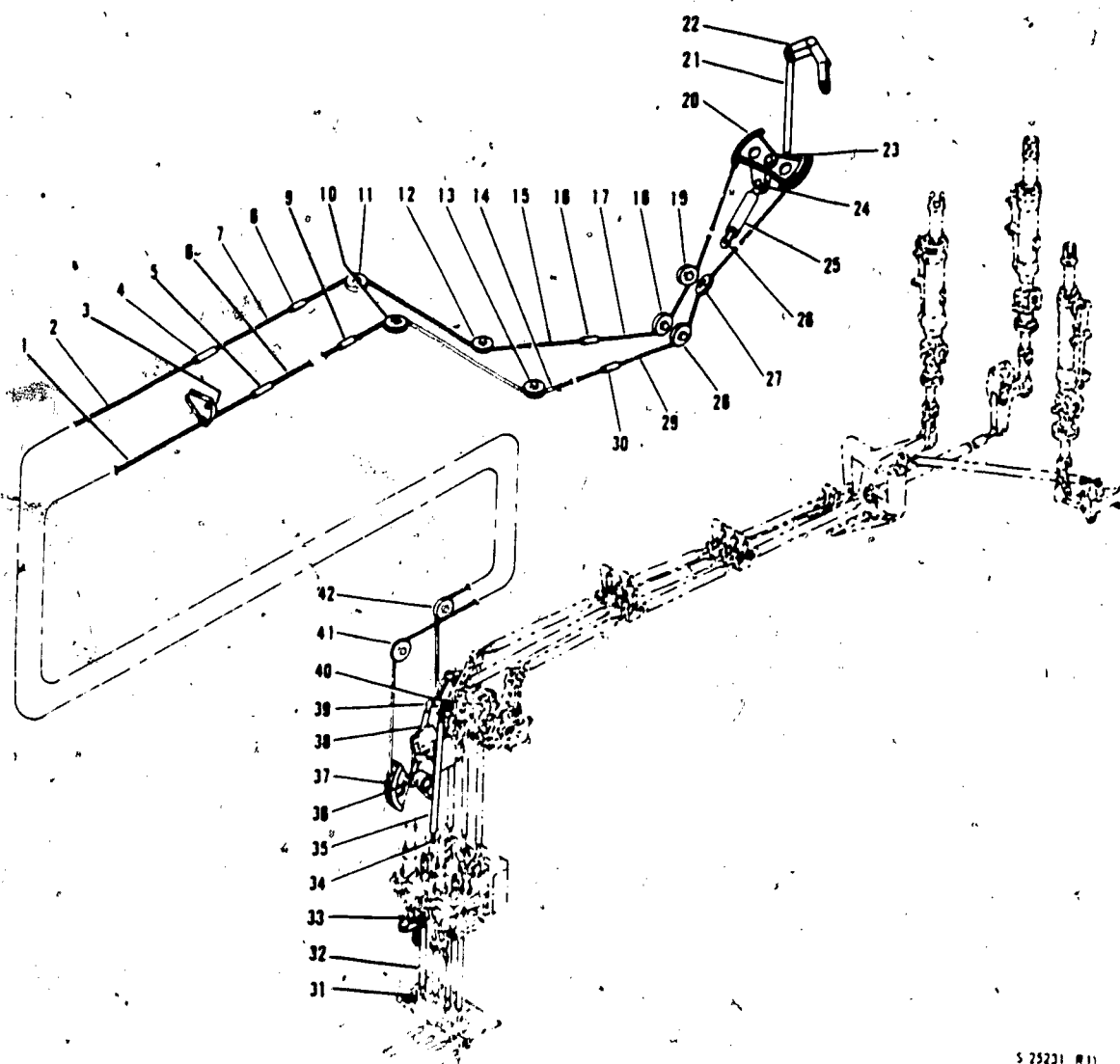
- 1 Grip
- 2 Screw, Nut
- 3 Bushing
- 4 Rivet
- 5 Locking Fitting

- 6 Sleeve
- 7 Screw, Washer, Lockwasher
- 8 Collet
- 9 Stick

- 10 Bolt, Washers, Nut
- 11 Socket
- 12 Protective Tubing
- 13 Wiring
- 14 Disconnect Plug

- 15 Grommet
- 16 Drag Strut
- 17 Bolt, Spacer, Washer
- 18 Guard

Figure 37. - Collective control stick.



S 25231 R11

- | | | | |
|--------------|-----------------------------------|-----------------------------------|----------------------------------|
| 1 Cable | 15 Cable | 25 Negative Force Gradient Spring | 34 Bolt, Washer, Nut, Cotter Pin |
| 2 Cable | 16 Turnbuckle | 26 Bolt, Washers, Nut, Cotter Pin | 35 Control Rod |
| 3 Pulley | 17 Cable | 27 Pulley | 36 Bolt, Washer, Nut, Cotter Pin |
| 4 Turnbuckle | 18 Pulley | 28 Pulley | 37 Quadrant (Forward) |
| 5 Turnbuckle | 19 Pulley | 29 Cable | 38 Control Rod |
| 6 Cable | 20 Quadrant (Aft) | 30 Turnbuckle | 39 Bolt, Washer, Nut, Cotter Pin |
| 7 Cable | 21 Control Rod | 31 Bolt, Washer, Nut, Cotter Pin | 40 Bolt, Washer, Nut, Cotter Pin |
| 8 Turnbuckle | 22 Bolt, Washers, Nut, Cotter Pin | 32 Control Rod | 41 Pulley |
| 9 Turnbuckle | 23 Bolt, Washers, Nut, Cotter Pin | 33 Bolt, Washer, Nut, Cotter Pin | 42 Pulley |
| 10 Pulley | 24 Bolt, Washers, Nut, Cotter Pin | | |
| 11 Pulley | | | |
| 12 Pulley | | | |
| 13 Pulley | | | |
| 14 Cable | | | |

Figure 38. - Tail rotor flight control system (fuselage section).

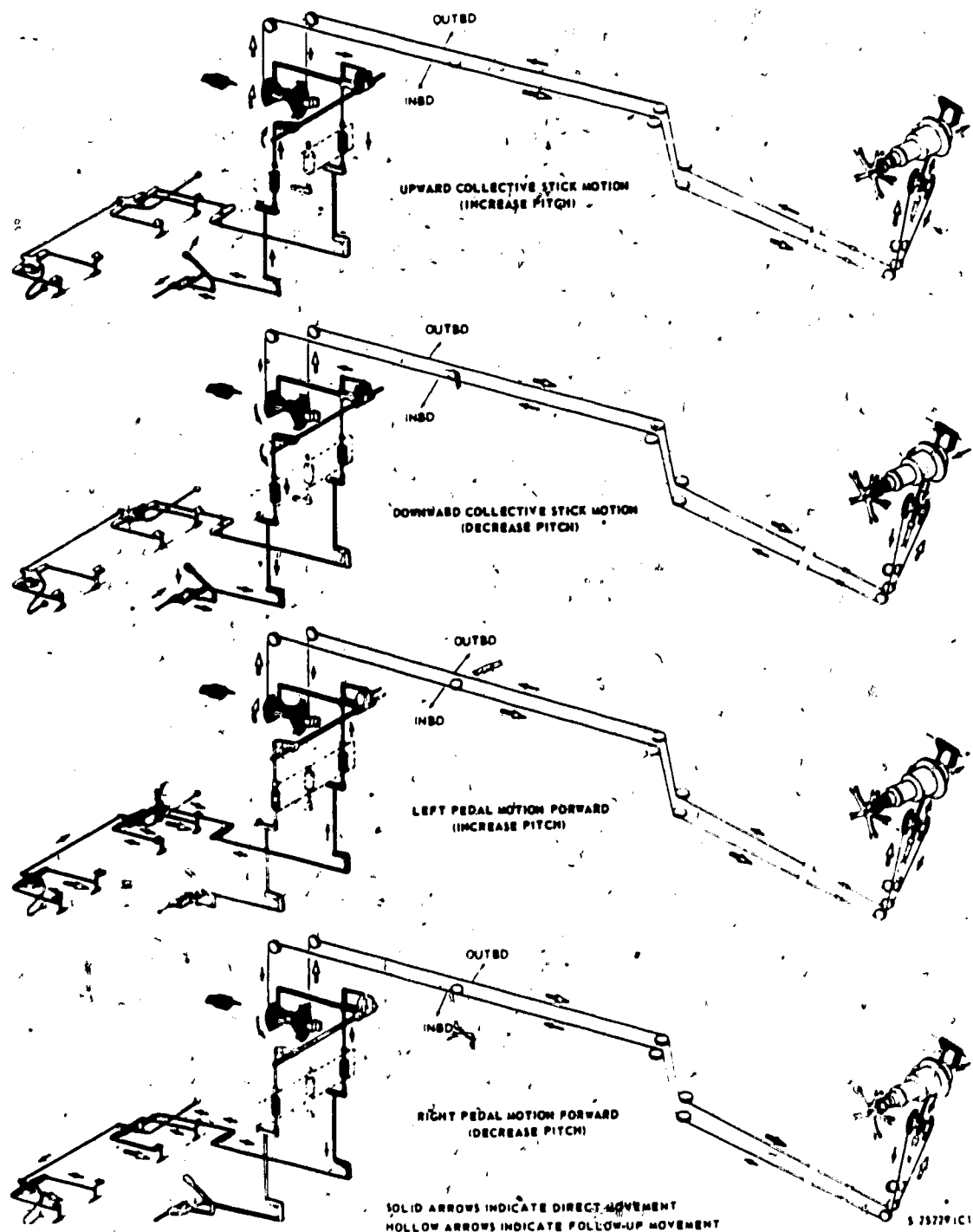


Figure 39. - Negative force gradient spring.

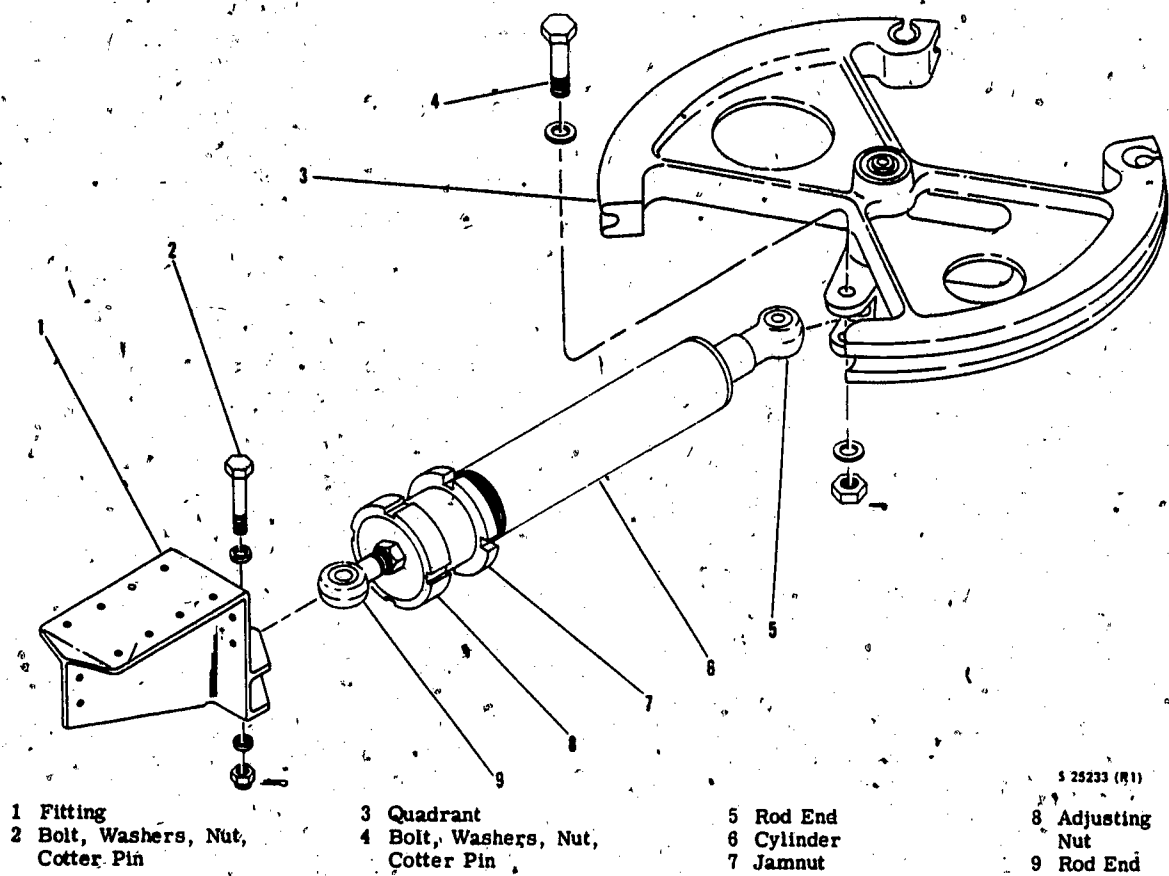


Figure 40. - Tail rotor flight control system - directional movement.

REVIEW

This section has dealt with the flight control system and its components.

(Now answer the following review questions.)

27. The cyclic control stick trim system holds the stick in a selected trim position by the use of _____.

- A. electrical power
- B. hydraulic pressure
- C. mechanical linkage
- D. friction blocks

27.-B (Refer to page 34)

28. When the main rotor blade pitch is increased, tail rotor blade pitch is automatically increased by the action of the _____.

- A. negative force gradient spring
- B. primary servocylinders
- C. stick trim system
- D. mixing unit

28.-D (Refer to page 37)

29. The purpose of the cyclic control stick trim system is to _____.

- A. provide a hydraulic boost for operating the flight controls
- B. keep the helicopter on a straight and level flight
- C. act as a substitute for the auxiliary servocylinder
- D. provide a fine degree of cyclic pitch control during flight

29.-D (Refer to page 37)

30. The pilot can change the collective pitch stick "feel" by adjusting the _____.

- A. stick trim system
- B. AFCS control
- C. friction lock
- D. BAR ALT control

30.-C The friction lock is used to lock the collective pitch lever in a set position. (Refer to page 38)

31. Which electrical switches are on the collective control stick grip?

1. TRIM REL.
2. CPLR RELEASE
3. CARGO
4. BAR. REL.
5. PRI. OFF - AUX. OFF
6. ENG. ST.

31.-B (Refer to page 38)

- A. 1, 3, and 6 only
- B. 2, 4, and 5 only
- C. 1, 3, 4, and 6
- D. 2, 3, 5, and 6

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32. Sudden movements of the tail rotor control pedals are prevented by _____.

- A. a pedal damper in the auxiliary servocylinder
- B. mechanical stops at the extreme ends of pedal travel
- C. a restrictor assembly in the control rigging
- D. a counterweight assembly on the tail rotor blades

33. If the auxiliary hydraulic system is turned off during flight, feedback loads exerted by the tail rotor are cancelled by the _____.

- A. pedal adjustor
- B. auxiliary servocylinder
- C. aft quadrant
- D. negative force gradient spring

32.-A The damper restricts the hydraulic fluid flow. (Refer to page 39)

33.-D (Refer to page 40)

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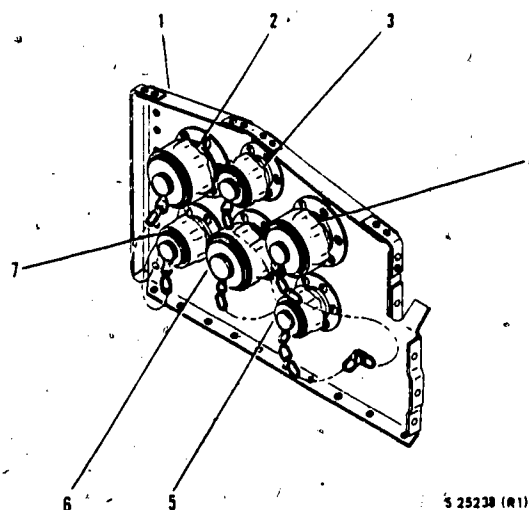
PRIMARY HYDRAULIC SYSTEM (Figure 42)

Turn to figure 42 as an aid in understanding the following primary hydraulic system description. The system is one of two independent hydraulic systems which provide power to assist in flight control. Hydraulic power for maintenance may be obtained from an external source connected to the external hydraulic pressure connections or by operation of the APU. In flight, the hydraulic pump (18), driven by the main gear box, supplies 1,500 psi pressure to the panel package (8), which provides constant pressure to the servocylinders (22). The panel package also protects the hydraulic pump by allowing hydraulic fluid to return to the fluid tank for cooling when the system is shut off. The pressure switch (7) is connected to the auxiliary hydraulic system to prevent the primary hydraulic system from being shut off should the auxiliary hydraulic system fail. The switch also controls the PRI-HYD PRESS light, capsule on the caution/advisory panel. Primary hydraulic pressure is displayed on the HYD PRESS PRI indicator on the instrument panel. Access to the pump and panel package is from the right transmission service platform. Fluid tank access is from the left transmission service platform through the hydraulic refill access panel in the aft main rotor head fairing. During normal operation, the circuit extends from the circuit breaker through the pressure switch on the auxiliary hydraulic panel package to the servo switch. In the PRI OFF position, the circuit continues to the primary hydraulic system panel package solenoid shutoff valve. If auxiliary hydraulic system pressure drops below 1,000 psi pressure, the pressure switch opens, causing the primary hydraulic system solenoid shutoff valve to open. The AUX-HYD PRESS warning light will illuminate and the PRI-HYD PRESS warning light will go off as pressure builds up in the primary hydraulic system.

EXTERNAL HYDRAULIC PRESSURE CONNECTIONS (Figure 41)

Primary hydraulic system pressure and supply connections are installed on the coupling support, aft and to the right of the main gear box. When not in use, the connections are covered with dust caps to

prevent entry of foreign matter. Access to these connections is gained by hinging down the right transmission service platform.



- 1 Coupling Support
- 2 AFCS SERVO SUPPLY Connection
- 3 UTILITY PRESSURE Connection
- 4 PRI SERVO SUPPLY Connection
- 5 PRI SERVO PRESSURE Connection
- 6 UTILITY SUPPLY Connection
- 7 AFCS SERVO PRESSURE Connection

Figure 41. - External hydraulic pressure connections.

PRIMARY PANEL PACKAGE

The primary panel package (figure 42, item 8) contains a 10-micron filter, differential pressure indicator pin, pressure relief valve, restricting orifice plug, snubber, and a solenoid shutoff valve. The panel package directs and controls flow of hydraulic fluid in the system. The filter helps to protect the system from foreign particles. Should the filter become clogged, the differential pressure indicator pin will extend at 100 ± 20 psi differential pressure. The relief valve protects the system by bypassing hydraulic fluid exceeding 1,750 psi pressure and directing it to the fluid tank. The snubber dampens and prevents surges from entering the pressure switch and pressure transmitter. Hydraulic fluid returns to the fluid tank to cool the hydraulic pump by way of the restricting orifice plug when the solenoid shutoff valve is off. The restricting orifice plug is color coded blue for identification and has a rated flow of 10

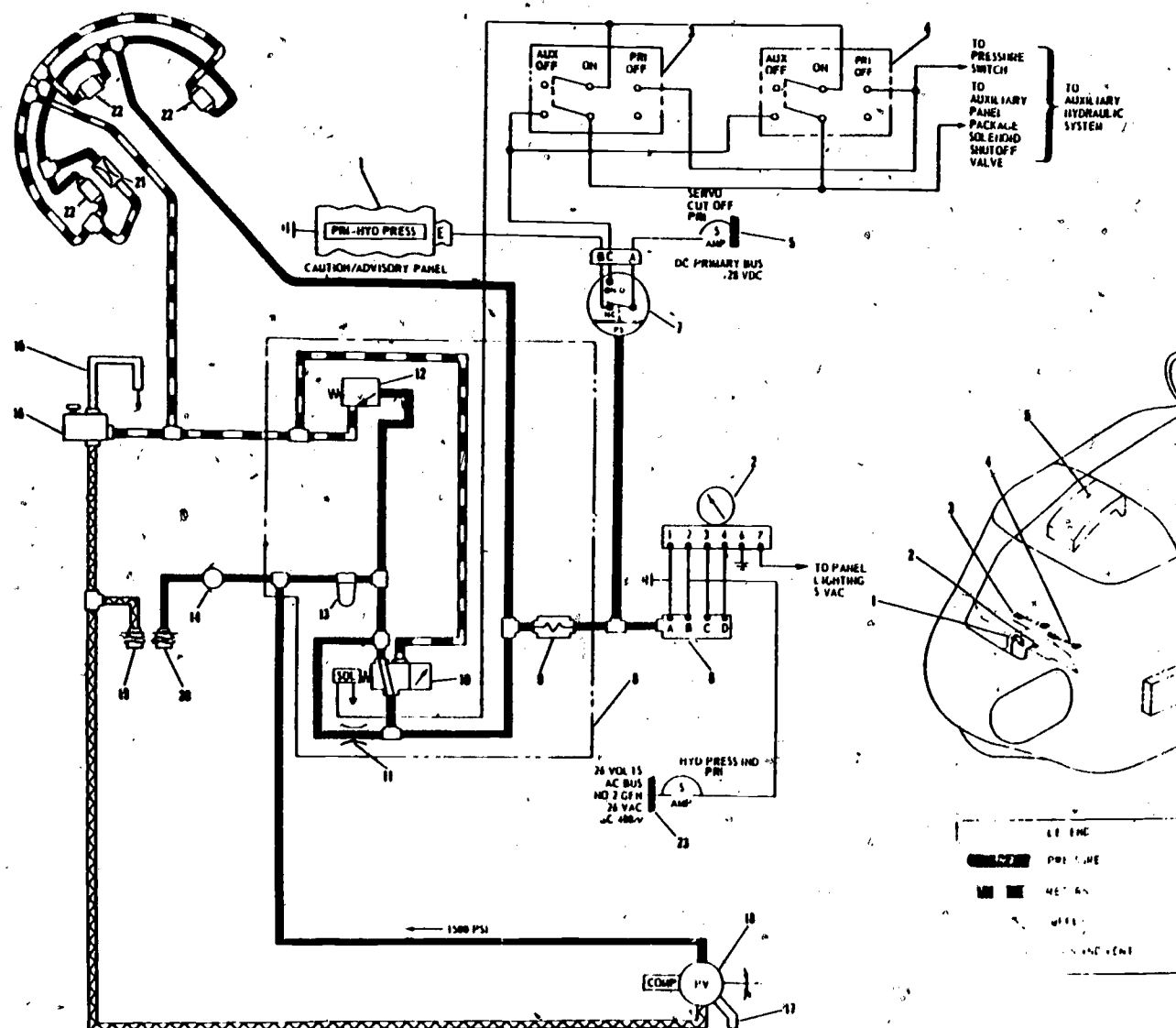


Figure 42. - Primary hydraulic system schematic diagram.

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Key to Figure 42.

1. Low Pressure Warning Light
2. Pressure Indicator
3. Servo Switch (Pilot's)
4. Servo Switch (Copilot's)
5. (Overhead Control Panel) SERVO CUT OFF PRI Circuit Breaker
6. Pressure Transmitter
7. Pressure Switch
8. Primary Panel Package
9. Snubber
10. Solenoid Shutoff Valve
11. Restricting Orifice Plug
12. Pressure Relief Valve
13. 10-Micron Filter
14. External Pressure Check Valve
15. Vent and Overboard Drain
16. Fluid Tank
17. Overboard Drain
18. Hydraulic Pump
19. External Supply Coupling
20. External Pressure Coupling
21. Two-Way Restrictor
22. Primary Servocylinders
23. (Copilot's Circuit Breaker Panel) HYD PRESS IND PRI Circuit Breaker

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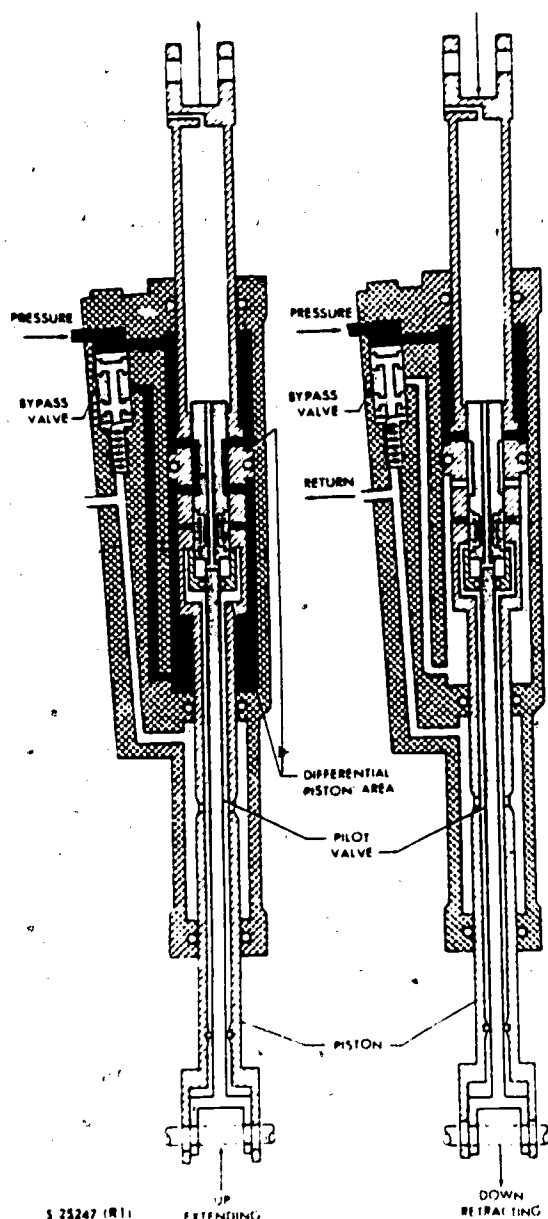


Figure 43. - Primary servocylinder schematic diagram.

GPM. A spring-loaded normally open solenoid shutoff valve passes hydraulic fluid to the primary servocylinders.

PRIMARY SERVOCYLINDERS (Figures 43 and 44)

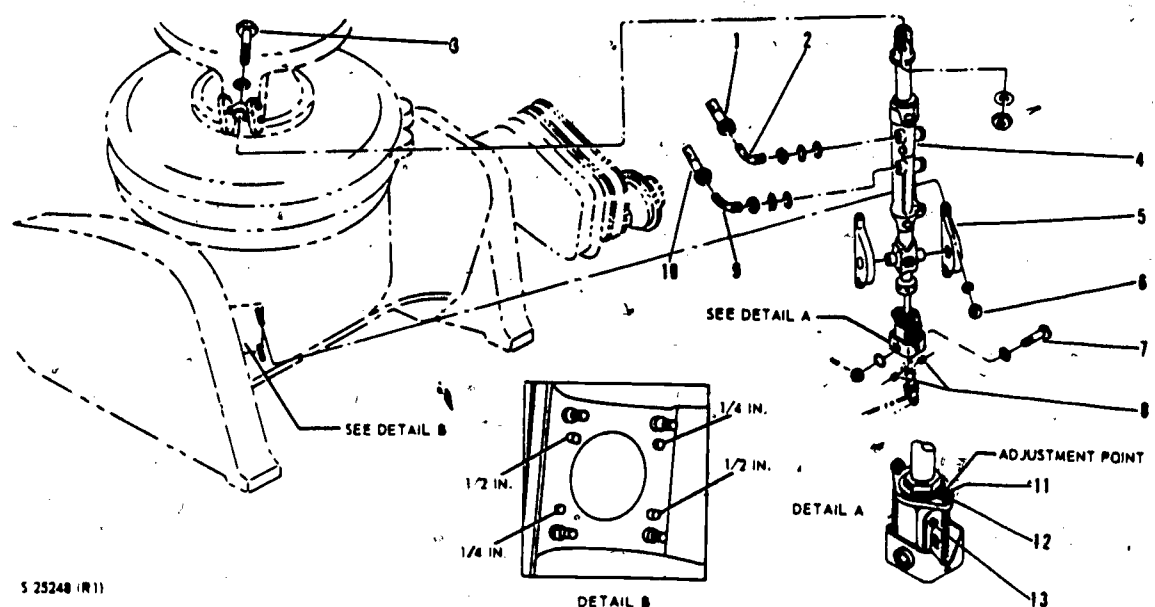
Three primary servocylinders, mounted on the main gear box, transmit flight con-

trol movements to the stationary swashplate of the main rotor head. If the primary hydraulic system is operating, the primary servocylinders hydraulically assist in flight control. If pressure is turned off or fails, the servocylinders function only as control rods. This is done by a spring-loaded bypass valve which prevents hydraulic lock and a sloppy link pilot valve connection. The pilot valve and the lower clevis of the power piston are connected to the flight control system by the same bolt. The close tolerance between the connection to the pilot valve causes activation of the pilot valve before the loose fit at the power piston clevis is taken up and the power piston is mechanically displaced. Pressure entering the HI port of the primary servocylinder closes the bypass valve and enters the upper chamber of the servocylinder. With the pilot valve in neutral, fluid cannot escape from the lower chamber and the piston remains motionless. If the pilot valve clevis is moved upward, the pilot valve will port fluid into the lower chamber, and the piston will rise due to the area differential. If the clevis is moved down, the fluid in the lower chamber is ported to return, and the piston will be forced downward by the pressure in the upper chamber. When flight control movements stop, the piston will continue to move until the ports of the pilot valve close. The pilot valve clevis will then be in the center of the sloppy link. When pressure is turned off, the bypass valve will open, preventing hydraulic lock.

Each primary servocylinder is identical except for installation of boot strap springs (figure 44, item 13) on the lateral servocylinders and the relative angular adjustment of the lower power piston clevis. The fore and aft primary servocylinder piston clevis is 0.250 inch shorter. After angles are established, the pilot valve must be centered on the bolt hole center in the power piston clevis. The boot strap springs aid in supporting the collective pitch stick when the auxiliary hydraulic system is turned off.

SERVO SELECTOR SWITCH

A double-pole three-position servo selector switch (figure 42, items 3 and 4) is on the pilot's and copilot's collective control stick grips. The servo selector



- 1 Pressure Hose
- 2 Elbow, Nut, Ring, Gasket
- 3 Bolt, Washers, Nut, Cotter Pin (Stainless Steel)
- 4 Primary Servocylinder
- 5 Bracket
- 6 Washer, Nut

- 7 Bolt, Washer, Nut, Cotter Pin
- 8 Sleeve Bushings
- 9 Elbow, Nut, Ring, Gasket
- 10 Return Hose
- 11 Pin
- 12 Bolt
- 13 Spring

Figure 44. - Primary servocylinders.

switch shuts off either the primary or the auxiliary hydraulic system. When the switch is in the centered position, both systems are operating. To make sure of safe operation, only one system at a time can be shut off by selecting either the PRI OFF or the AUX OFF positions.

PRIMARY PRESSURE SWITCH

The primary pressure switch (figure 42, item 7), is mounted on the auxiliary panel package. The switch electrically connects the primary hydraulic system to the solenoid shutoff valve in the primary hydraulic system through the servo selector switch on the pilot's collective pitch control stick grip. In normal flight position, the primary and auxiliary solenoid shutoff valves are in the de-energized position until the servo selector switch is actuated. With the servo selector switch in the PRI OFF position, a circuit is completed from

the auxiliary panel package pressure switch to the primary servocylinder panel package solenoid shutoff valve, energizing it. A circuit is then completed from the primary panel package pressure switch to the PRI-HYD PRESS and MASTER CAUTION lights on the instrument panel shield in the cockpit. If the pressure in the auxiliary system drops below 1,000 psi pressure, the circuit between the primary pressure switch and the primary panel package solenoid shutoff valve is broken and the solenoid shutoff valve is de-energized. This allows primary hydraulic pressure to return to the flight controls. Power for the pressure switch is supplied by the DC primary bus system through the SERVO CUT-OFF PRI circuit-breaker on the overhead control panel.

PRIMARY HYDRAULIC INDICATING SYSTEM (Figure 42)

The primary hydraulic indicating system consists of a pressure transmitter and indicator. Hydraulic pressure in the primary

hydraulic system is directed to the pressure transmitter for generation of electrical impulses to the indicator. A snubber in the primary panel package stabilizes the hydraulic pressure for accurate indications and tends to protect the transmitter from damage due to pressure surge.

AUXILIARY HYDRAULIC SYSTEM (Figure 45)

Turn to figure 45 as an aid in understanding the following auxiliary hydraulic system description. The auxiliary hydraulic system consists of a fluid tank (18), hydraulic pump (5), panel package (11), pressure switch (17), pressure transmitter (9) and support, PRI OFF-AUX OFF switch, pressure reducer (22), servocylinder (21), and servocylinder filter (20). The system is one of two independent hydraulic systems which provide power to assist in flight control. Hydraulic power for maintenance may be obtained from an external source connected to the external hydraulic pressure connections or by operation of the auxiliary power plant. In flight, the hydraulic pump, driven by the main gear box, supplies 1,500 psi pressure to the panel package, which provides a constant pressure to the servocylinder. The panel package also protects the hydraulic pump by allowing hydraulic fluid to return to the fluid tank for cooling when the system is shut off. The pressure switch is connected in the control circuit of the primary hydraulic system to prevent it from being shut off if the auxiliary hydraulic system is turned off or should fail. The switch also controls the AUX-HYD PRESS warning light on the caution advisory panel. Auxiliary hydraulic pressure is displayed on the HYD PRESS AUX indicator on the instrument panel (figure 46). The five-micron servocylinder filter protects the servocylinder from contamination. Access to the pump, panel package, and fluid tank is from the right transmission service platform and through the hydraulic refill access panel in the aft main rotor head fairing. During normal operation, the circuit extends from the circuit breaker through the primary panel package pressure switch to the PRI OFF-AUX OFF switch. In the AUX OFF position, the circuit continues to the auxiliary panel package. If primary hydraulic pressure drops below 1,000 psi pressure, the PRI HYD PRESS light will illuminate and the AUX-HYD PRESS warning light will go off as pressure builds up in the auxiliary hydraulic system.

EXTERNAL HYDRAULIC PRESSURE CONNECTIONS (Figure 41)

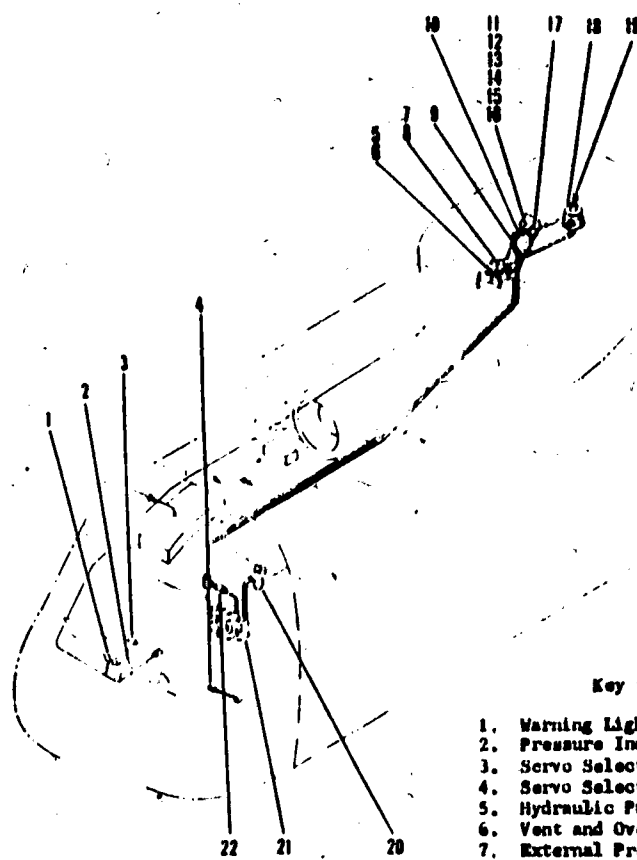
Auxiliary system pressure and supply connections are installed on the coupling support aft and to the right of the main gear box. When not in use, the connections are covered with dust caps to prevent entry of foreign matter into the system. Access to these connections is gained by hinging down the right transmission service platform.

AUXILIARY PANEL PACKAGE

The auxiliary panel package (figure 45, item 11) contains a 10-micron filter, differential pressure indicator pin, pressure relief valve, restricting orifice plug assembly, snubber, and a solenoid-operated shutoff valve. The panel package directs and controls the flow of hydraulic fluid in the system and is in the aft main rotor fairing. The filter protects the system from foreign particles. Should the filter become clogged, the differential pressure indicator pin will extend at 100 ± 20 psi differential pressure. The relief valve protects the system by bypassing hydraulic fluid exceeding 1,750 psi pressure and directing it to the fluid tank. The snubber dampens and prevents pressure surges from entering the pressure switch and pressure transmitter. The restricting orifice plug permits hydraulic fluid to return to the fluid tank to cool the hydraulic pump when the system is shut off. The restricting orifice plug is color coded blue for identification. A spring-loaded normally open solenoid shutoff valve passes the hydraulic fluid to the auxiliary servocylinder. Power for the solenoid shutoff valve is supplied by the primary DC bus system through the SERVO.

AUXILIARY SERVOCYLINDER (Figure 47)





The auxiliary servocylinder in the AFCS controls compartment consists of four separate banks of servo mechanisms constructed as one unit. The power pistons of each bank transfer flight control movements mechanically or assist them hydraulically before they are fed to the mixing unit. The



Key to Figure 45.

1. Warning Light
2. Pressure Indicator
3. Servo Selector Switch (Pilot's)
4. Servo Selector Switch (Copilot's)
5. Hydraulic Pump
6. Vent and Overboard Drain
7. External Pressure Coupling
8. External Supply Coupling
9. Pressure Transmitter
10. External Pressure Check Valve
11. Auxiliary Panel Package
12. Snubber
13. Restricting Orifice Plug
14. Solenoid Shutoff Valve
15. 10-Micron Filter
16. Pressure Relief Valve
17. Pressure Switch
18. Fluid Tank
19. Vent and Overboard Drain
20. Five-Micron Filter
21. Auxiliary Servocylinder
22. Pressure Reducer

LEGEND

	PRESSURE
	RETURN
	SUPPLY
	DRAIN AND VENT

auxiliary servocylinder operates on mechanical input during manual operation of the flight controls, on electrical input of the AFCS, and by electrical input of the stick trim system. The directional bank is the hydraulic assist to the tail rotor only. Hydraulic power for the auxiliary servocylinder is supplied by the auxiliary hydraulic system at 1,500 psi pressure and reduced to 60 psi pressure for beeper trim valve operation. Each of the four banks of the auxiliary servocylinder operates in a single area of control, functioning as fore-and-aft, lateral, collective, and directional (or yaw) hydraulic assists. Each bank incorporates a dual input hydraulic servo valve, capable of being displaced by either mechanical or electrical (AFCS) input signals. The fore-and-aft and the lateral banks incorporate a pair of solenoid-operated stick trim valves, which control fore, aft, and lateral movements through the stick trim and AFCS systems. The directional bank incorporates a pedal damping piston, which restricts sudden changes in the heading of the helicopter.

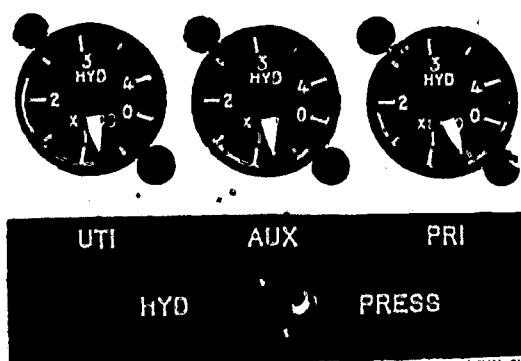
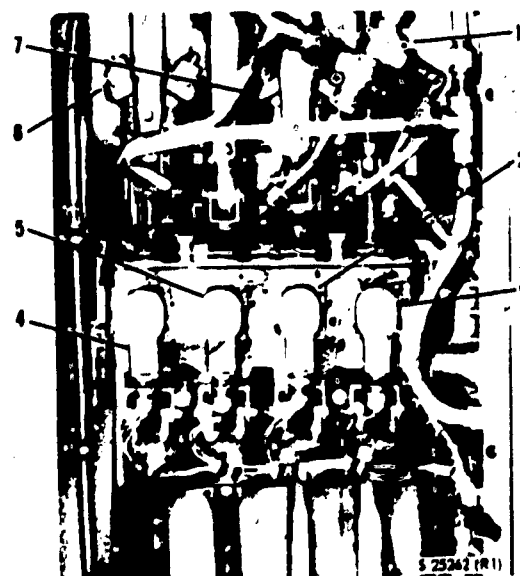


Figure 46. - Pressure indicators.

OPERATIONAL DESCRIPTION (Figure 48.)

The following paragraphs describe the mechanical and hydraulic operation of the auxiliary servocylinder when the flight controls are operated manually, by the stick trim system, or by the AFCS. (Fold out figure 48 and refer to it as you read the following discussion.) The auxiliary servocylinder operates at 1,500 psi hydraulic pressure supplied by the auxiliary pump.

a. Hydraulic pressure for the lateral and fore-and-aft banks (detail A) enters



- | | |
|---|---|
| 1 Pressure Reducer | 5 Collective AFCS Servo Valve |
| 2 Fore-and-Aft (Pitch) AFCS Servo Valve | 6 Lateral (Roll) Stick Trim Valve |
| 3 Yaw AFCS Servo Valve | 7 Fore-and-Aft (Pitch) Stick Trim Valve |
| 4 Lateral (Roll) AFCS Servo Valve | |

Figure 47. - Auxiliary servocylinder installed.

at port C moving the bypass valve against the spring to close the internal bypass ports and open the sloppy link at F. The pressure, entering at port D, supplies the power to operate the trim piston. The normally closed stick trim valves trap the fluid on one side of the trim piston, and pressure is applied to the other side preventing the trim piston from moving. Any movement of the flight controls is absorbed by the trim piston spring. The pressure, entering at port E, operates the power piston through the pilot valve. Movement of the flight controls in direction Z moves the pilot valve in direction X. This ports the pressure to one side of the power piston, and return from the other side moves the power piston in direction Y.

b. Removing the hydraulic pressure (detail B) allows the spring to position the bypass valve. This opens the bypass ports and allows the trapped fluid to pass from one side of the power piston to the other, preventing a hydraulic lock. Also, the sloppy link at F closes on the clevis pin, making a fulcrum upon which the power piston is moved mechanically.

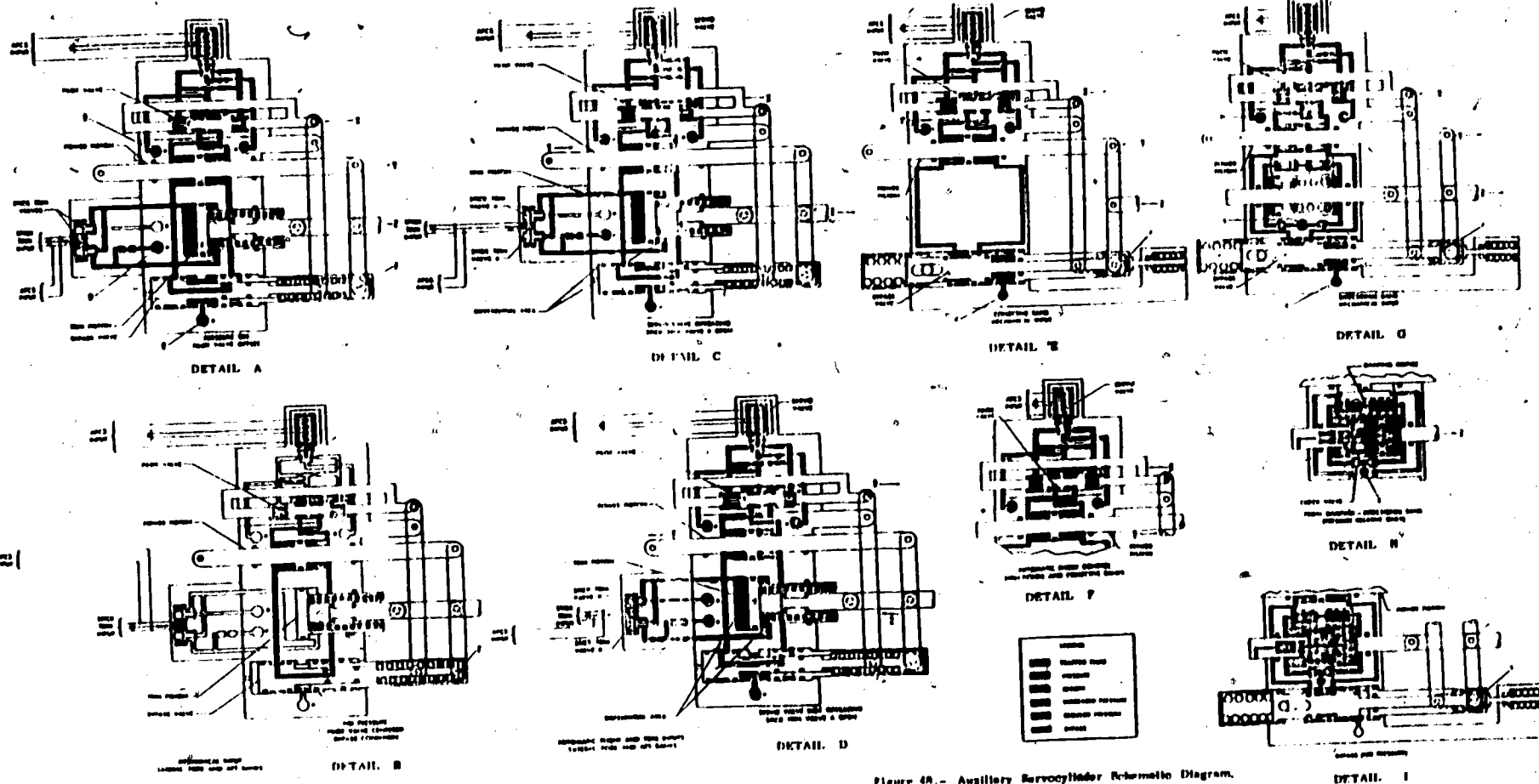


Figure 4A.- Auxiliary Servocylinder Schematic Diagram.

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c. Upon receiving a signal, the AFCS servo valve (detail C) restricts return from one side of the pilot valve, increasing the pressure on that side of the pilot valve. The servo valve opens the return from the other side of the pilot valve, moving the pilot valve in direction X. As the pilot valve moves, pressure is ported to one side of the power piston and returns from the other side. This moves the power piston in direction Y.

d. Upon receiving a signal, the stick trim valve B (detail C) opens, allowing pressure to flow to both sides of the trim piston. Since the area on one side of the trim piston is greater than the other side, the piston will move in direction Z. This will move the pilot valve in direction X and port the pressure to move the power piston in direction Y.

e. When the stick trim valve A (detail D) opens, the trapped fluid is vented to return from the large face area of the trim piston. Stick trim valve B remains closed, directing the pressure to the smaller face area, moving the trim piston in direction Z, moving the pilot valve in direction X, and porting the pressure to move the power piston in direction Y.

f. Hydraulic pressure at the collective bank (detail E) enters at port C, positioning the bypass valve to close the bypass ports, and opens the sloppy link at F. Pressure also enters at port D. Movement of the flight controls in direction Z moves the pilot valve in direction X, porting the pressure to one side of the power piston and return from the other side. This moves the power piston in direction Y.

g. Hydraulic pressure for the directional and collective banks enters at port D (detail F). Upon receiving a signal, the AFCS servo valve restricts return from one side of the pilot valve, increasing the pressure in that side of the pilot valve, and opens the return from the other side of the pilot valve. This moves the pilot valve in direction X. As the pilot valve moves, the pressure is ported to one side of the power piston and return from the other side. This moves the power piston in direction Y.

h. Hydraulic pressure enters at port C (detail G), positioning the bypass valve

to close the bypass ports and open the sloppy link at F. Pressure also enters at ports D and E. A movement of the directional pedals reacts to move the flight controls in direction Z, moving the pilot valve in direction X, porting the pressure to one side of the power piston and return from the other side. This moves the power piston in direction Y.

i. As the pedals move the flight controls in direction Z (detail H), pressure is increased on one side of the pedal damping piston, sealing the check valve on the pressure side and forcing the fluid through the damping orifice at a controlled rate. Hydraulic fluid entering at port E maintains a supply to the cylinder. The spring in the piston absorbs the initial movement of the pedals to allow slight, unrestricted changes in heading.

j. Removing hydraulic pressure (detail I) causes the spring to position the bypass valve, opening the bypass ports. This allows the trapped fluid to pass from one side of the pedal damper piston to the other, preventing a hydraulic lock. Also the sloppy link at F closes on the clevis pin, making a fulcrum upon which the power piston may be moved mechanically.

AUXILIARY PRESSURE SWITCH

The auxiliary pressure switch (figure 45, item 17), on the primary panel package, electrically connects the auxiliary hydraulic system to the solenoid shutoff valve in the auxiliary hydraulic system through the servo selector switch on the pilot's or copilot's collective control stick grip. In normal flight position, the auxiliary and primary solenoid shutoff valves are in the de-energized position until the servo selector switch is actuated. With the servo selector switch in the AUX OFF position, a circuit is completed from the primary panel package pressure switch to the auxiliary panel package solenoid shutoff valve, energizing it. A circuit is then completed from the auxiliary panel package pressure switch to the AUX-HYD PRESS lights on the caution/advisory panel and the MASTER CAUTION lights in the cockpit. If the pressure in the primary hydraulic system drops below 1,000 psi pressure, the circuit between the primary panel package pressure switch

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and the auxiliary panel package solenoid shutoff valve is broken, and the valve is de-energized, allowing hydraulic pressure to return to the flight controls. Power

for the pressure switch is supplied by the DC primary bus system through the SERVO CUT-OFF AUX circuit breaker on the over-head control panel.

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REVIEW

You have just completed the material dealing with the primary and auxiliary hydraulic systems.

(Now answer the following review questions.)

34. What happens if the pressure in the auxiliary hydraulic system drops below 1,000 psi?

- A. The auxiliary hydraulic system is automatically shut off
- B. The primary hydraulic system cannot be shut off
- C. The auxiliary system is pressurized by primary system pressure
- D. The primary system is automatically shut off

34.-B (Refer to page 47)

35. What is the purpose of the restricting orifice plug in the primary panel package?

- A. Maintain fluid flow for pump cooling
- B. Regulate system pressure
- C. Supply pressure to the system indicator
- D. Activate the bypass valve if the filter becomes clogged

35.-A (Refer to page 47)

36. If primary hydraulic system pressure is lost, the primary servocylinders will _____.

- A. assume a mid-range servocylinder piston position
- B. act as control rods to transmit control movements
- C. move to either extreme end of servocylinder piston travel
- D. become jammed in the last selected position

36.-B (Refer to page 51)

37. Which primary servocylinder component aids in supporting the collective pitch stick when the auxiliary system is turned off?

- A. Clevis
- B. Sloppy link
- C. Bypass valve
- D. Boot strap spring

37.-D (Refer to page 51)

38. How are the primary and auxiliary hydraulic systems inter-connected?

1. Mechanically
2. Electrically
3. Hydraulically

- A. 1 only
- B. 2 only
- C. 2 and 3 only
- D. 1, 2, and 3

39. Access to the auxiliary hydraulic system panel package is gained through the _____.

- A. right transmission service platform and the hydraulic refill access panel
- B. left transmission service platform
- C. left side of the "dog house"
- D. cabin overhead

40. To what pressure is auxiliary system pressure reduced for operation of the beeper trim valves?

- A. 1,500 psi
- B. 1,000 psi
- C. 500 psi
- D. 60 psi

41. A hydraulic lock within the auxiliary servocylinder piston chambers is prevented by the _____.

- A. pilot valve
- B. bypass valve
- C. servo valve
- D. fulcrum

42. Refer to figure 48, detail C, in your text. Assume that pressure is applied to the auxiliary servocylinder and stick trim valve "B" is opened. The trim piston will _____.

- A. move in direction "Z"
- B. become "pressure locked"
- C. move opposite to direction "Z"
- D. move in either direction depending upon movement of the power piston

43. Refer to figure 48, detail H. Initial movement of the tail rotor pedals is absorbed by a _____.

- A. check valve
- B. pedal damping piston
- C. spring within the damping piston
- D. fluid on either side of the damping piston

38.-B (Refer to page 52)

39.-A (Refer to page 53)

40.-D (Refer to page 57)

41.-B (Refer to page 57)

42.-A (Refer to page 59 and 61)

43.-C (Refer to page 59 and 61)

44. If the auxiliary servocylinder sloppy link closes on the clevis pin, the power piston is being moved _____.

44.-B (Refer to page 61)

- A. hydraulically
- B. mechanically
- C. by servo operation
- D. by the pilot valve

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T58-GE-5 ENGINE

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the engine and its components.
2. Explain the engine's various systems.
3. Summarize the emergency fuel control lever operation.
4. Outline the starter system and its operation.
5. Distinguish between the engine operating instruments.
6. Describe the engine fire extinguishing system.
7. Summarize the T58-GE-5 engine wash and rust lick procedures.

GENERAL ENGINE INFORMATION

The HH-3F is equipped with two General Electric T58-GE-5 engines (figures 49 and 50) each rated at 1500 SHP. Each T58 engine is a compact turboshaft engine with high power-to-weight ratio and uses the free turbine principle. The power turbine is mechanically independent of the gas generator and, within the power turbine governing range, power turbine speed is independent of output power. High torque is available at low output speeds, providing rapid acceleration characteristics. The engines are mounted side-by-side above the cargo compartment, forward of the main gear box.

Each engine consists of the following major components: an axial-flow compressor, combustion chamber, a two-stage gas generator turbine, and a single-stage free power turbine, which is independent of the gas generator turbine. The gas generator consists of the compressor, annular combustor, and two-stage gas generator turbine.

The free turbine principle provides a constant free turbine speed output which results in a constant rotor rpm. Variations in power requirements to maintain constant free turbine speed are accomplished by automatic increases or decreases in gas generator speed. A hydromechanical fuel metering unit provides maximum engine performance without exceeding safe engine operating

limits. In the normal operating range, engine speed is selected by positioning the speed selector. The integrated fuel control system delivers atomized fuel in controlled amounts to the combustion chamber. Flow of fuel and air through the combustion chamber is continuous, and once the mixture is ignited, combustion is self-sustained. Changes in air pressure, air temperature, and rotor operation all affect engine performance. With the FOD deflector installed, helicopter velocity has practically no effect on engine performance. The engine fuel control system automatically maintains selected power turbine speed by changing fuel flow to increase or decrease gas generator speed as required, thus regulating output power to match the load under changing conditions. A start bleed valve, mounted on the compressor, automatically opens during the starting cycle to bleed approximately 6.7% of compressor discharge airflow overboard. This decreases compressor discharge pressure, which lessens the possibility of compressor stall and allows the starter to accelerate the gas generator faster. The valve automatically opens when the starter is engaged and remains open for 3 to 7 seconds after starter dropout. A start fuel valve is installed between the engine fuel control and flow divider. This valve, when closed, shuts off auxiliary starting fuel flow. The valve may be used by the pilot during the starting cycle to reduce starting fuel flow which decreases the possibility of a hot start. (Refer to table 1 for engine start, wash, and rust lick procedures, page 81).

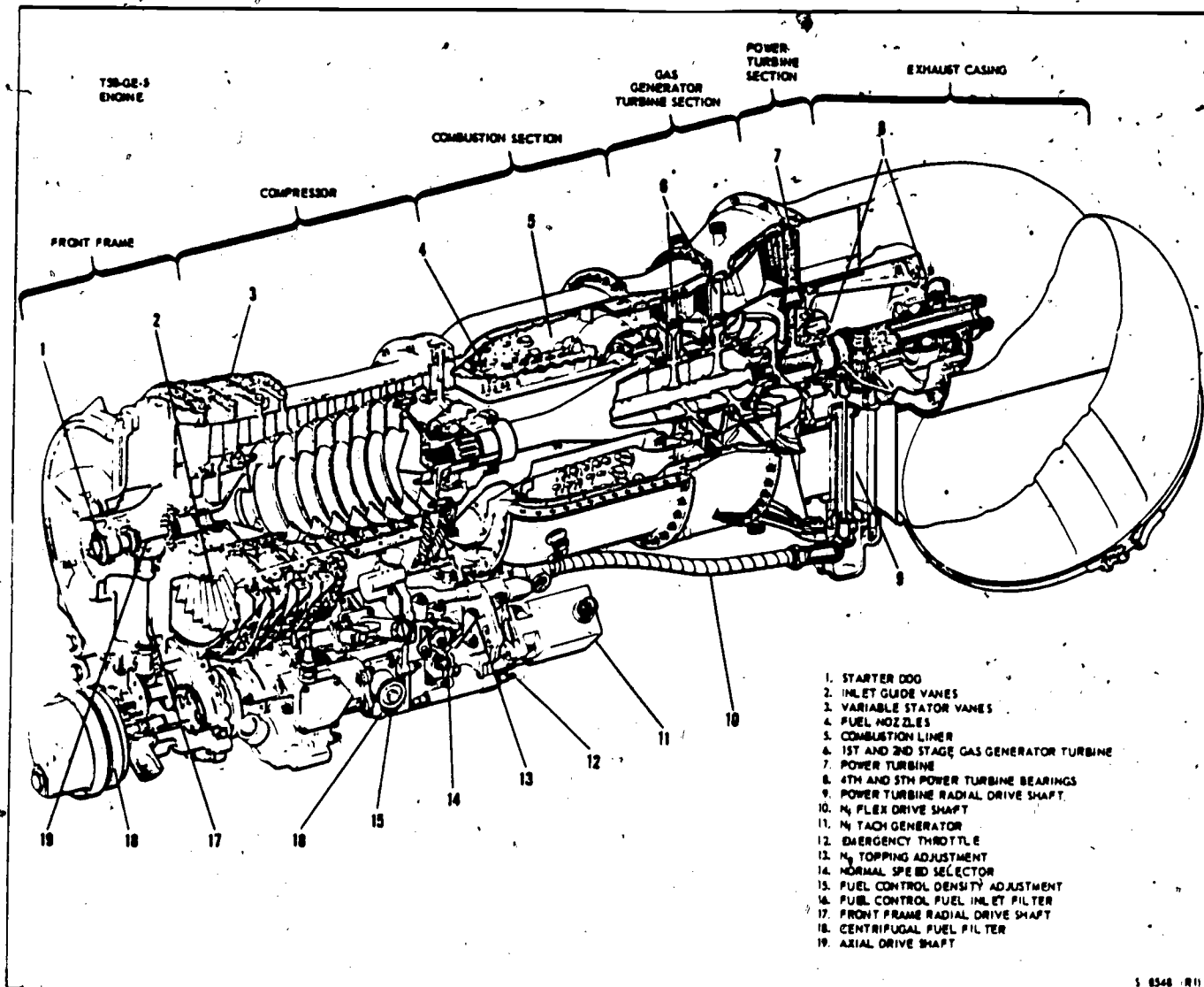


Figure 49. - Engine cutaway view.

COMPRESSOR

The ten-stage compressor consists of the compressor rotor and stator. The compressor rotor is supported by the front frame section and the compressor rear frame section. The stator is bolted between the front frame section and compressor rear frame. The primary purpose of the compressor is to compress air for combustion. Ambient air enters through the front frame and is directed to the compressor inlet, passes through ten stages of compression, and is directed to the combustion chambers. The

inlet guide vanes (2, figure 49) and the first three stages of the stator vanes (3, figure 49) are variable and change their angular position, as a function of compressor inlet temperature and gas generator speed, to prevent stall of the compressor.

COMBUSTION CHAMBER

In the combustion chamber fuel is added to the compressed air. This mixture is ignited, causing a rapid expansion of gases

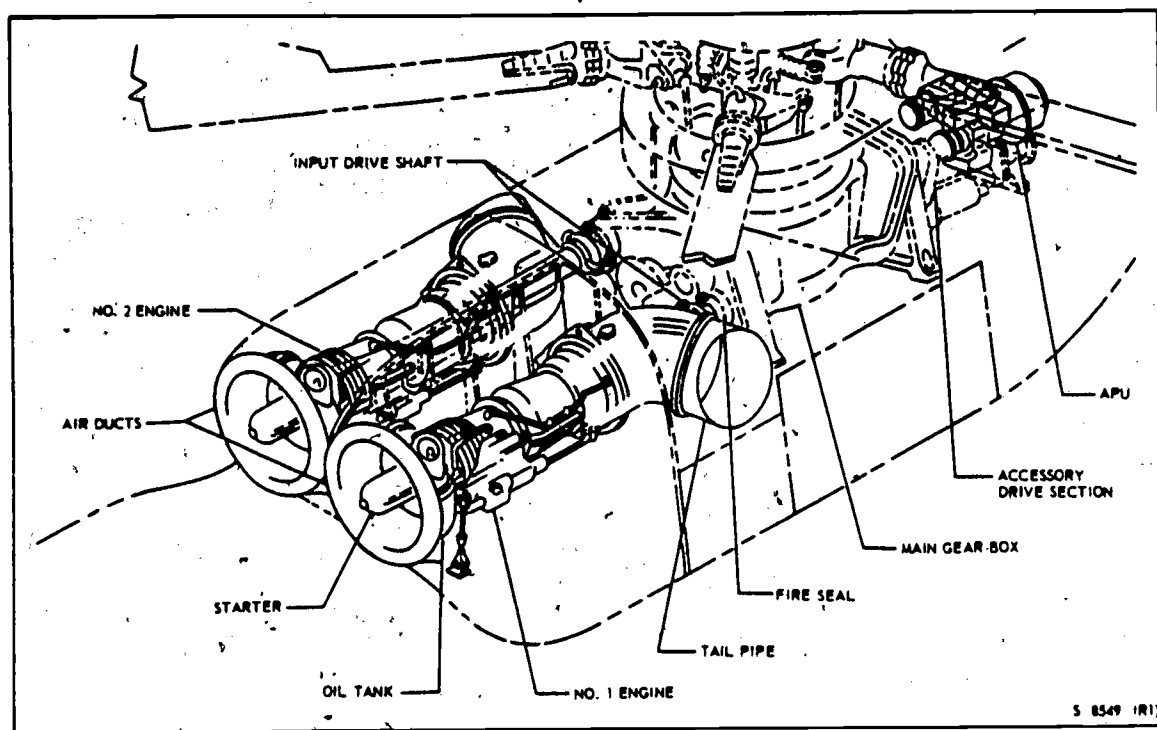


Figure 50. - Engine, main gear box, and APU installation.

toward the gas generator turbine section. As the air enters the combustion section, a portion goes into the combustion chamber where it is mixed with the fuel and ignited; the remaining air forms a blanket between the outer combustion casing and the combustion liner (5, figure 49) for cooling purposes. Once combustion is started by the two igniter plugs, it is self-sustaining. After the air has been expanded and increased in velocity by combustion, it is passed through the first-stage turbine wheel of the gas generator turbine (6, figure 49).

GAS GENERATOR TURBINE

The two-stage gas generator turbine (6, figure 49) is the rotating component coupled directly to the compressor. The turbine extracts the required power from the exhaust gases to drive the compressor. The turbine nozzles that comprise the stator blades direct the exhaust gases to the turbine wheels.

POWER TURBINE

The power turbine (7, figure 49) is bolted to the rear flange of the second-stage turbine casing. The engine uses the free turbine principle, in which engine output power is provided by the power turbine rotor, which is mechanically independent of the gas generator rotor. This rotor derives its power from the gases which are directed to it by the gas generator turbine nozzles. Within the normal operating range, power turbine speed may be maintained or regulated independent of output power. This principle also provides more rapid acceleration because of the availability of high engine torque at low output speeds.

GAS GENERATOR SPEED (N_g)

Gas generator speed (N_g) is primarily dependent upon fuel flow and is monitored by the engine fuel control unit. The principal purpose of monitoring N_g is to control acceleration and deceleration characteristics, prevent overspeed, and establish a

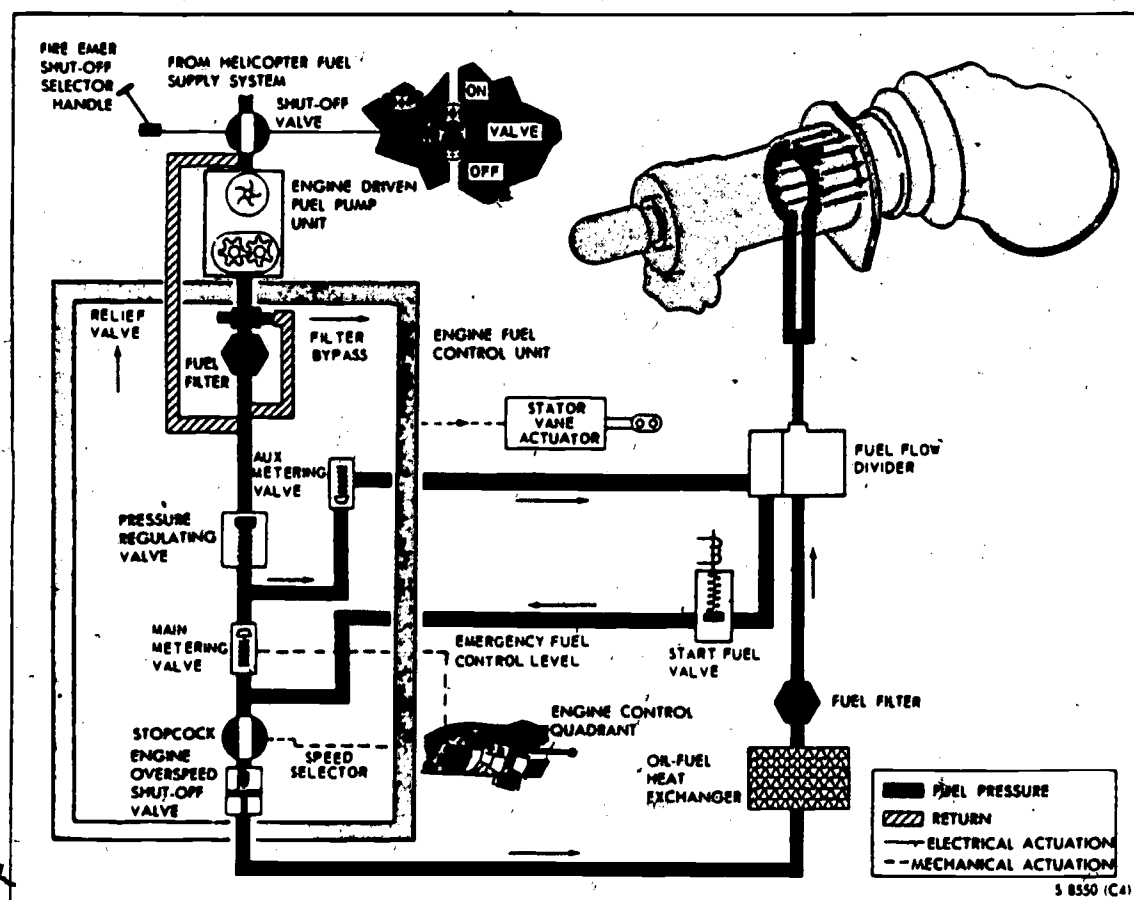


Figure 51. - Engine fuel system.

minimum idle setting. Gas generator speed controls mass airflow pumped through the engine and consequently the power available to the power turbine.

FREE POWER TURBINE SPEED (N_f)

The free power turbine speed (N_f) is dependent upon speed selector position and rotor load. The fuel control monitors N_f to regulate fuel flow to maintain an essentially constant power turbine speed for a given speed selector position.

ENGINE FUEL SYSTEM

An engine fuel system (figure 51) exists for each engine. Each system consists of an engine-driven pump; a dynamic

filter, a fuel control unit, a static filter, an oil cooler, a flow divider, a fuel manifold and associated piping. The fuel control unit is supplied fuel from the engine-driven fuel pump. Metered fuel from the engine fuel control unit is piped through an oil-fuel heat exchanger and then enters the flow divider connected directly to the fuel manifold on the engine. For normal flight, rotor speed is selected by positioning the speed selectors, and the engine fuel controls will meter fuel to maintain the selected rotor speed.

FUEL SYSTEM COMPONENTS

Engine-Driven Fuel Pump

A dual operation engine-driven fuel pump, mounted on each engine, is built into

a single housing. The pump consists of a positive displacement type gear pump and a centrifugal boost pump. Power for each pump is furnished from the engine accessory drive section by means of a splined shaft. This shaft drives the fuel pump and simultaneously acts as a link to transmit gas generator speed information to the engine fuel control unit. If the engine driven fuel pump or splined shaft fails, the engine will flameout due to fuel starvation.

Engine Fuel Control Unit

The engine fuel control units, one located on each engine, are hydro-mechanical units that regulate engine fuel flow to maintain, as selected, a constant free power turbine speed and thus maintain a constant rotor speed (N_r). Fuel from the engine fuel pump enters the fuel control unit through the inlet and passes through the fuel filter. The fuel control has a fuel metering section and a computing section. The metering section selects the rate of flow to the combustion chambers, based on information received from the computing sections. The metering section has a metering valve and a pressure regulating valve. The pressure regulating valve maintains a constant pressure across the main metering valve by bypassing excess fuel back to the engine fuel pump inlet. The metering valve is positioned in response to various internal operating signals, and meters fuel to the engine as a function of these integrated signals. The engine fuel control unit performs the following functions: prevents compressor stall, turbine overtemperature, rich or lean blow-outs; governs gas generator idle and maximum speeds; and schedules inlet guide and stator vane positions to provide optimum compressor performance.

SPEED SELECTORS (ENGINE SPEED SELECTOR LEVERS)

Two speed selectors, marked NUMBER 1 ENGINE and NUMBER 2 ENGINE, are located on the overhead engine control quadrant (figures 52 and 53.) Marked positions on the overhead quadrant are SHUT-OFF, GRD IDLE, MIN GOV, and 100% SPEED. The speed selectors are connected directly to the fuel stopcock and indirectly to the fuel metering valve in the fuel control unit.

When the speed selectors are in the SHUT-OFF position, fuel flow to the fuel

nozzles is stopped by means of a stopcock that prevents fuel from entering the combustion chambers. The stopcock is open whenever the speed selector is 6 degrees or more from the SHUT-OFF position and is closed when the speed selector is 3 degrees or less from the SHUT-OFF position.

The GRD IDLE position schedules fuel flow to produce approximately 56 percent N_g . Gas generator idle speed will vary with inlet air temperature. A limit stop at GRD IDLE prevents inadvertent retarding of the speed selectors below the idle speed of the engines. The speed selectors may be retarded from the limit stop by exerting a downward and rearward pressure on the speed selectors.

The MIN GOV position of the speed selector is the point where the governing range of the power turbine is entered and is approximately 87% N_r . When the speed selector is at the full forward position, the engine is producing maximum power turbine speed.

Engine speed trim switches are installed on the collective stick grip to provide accurate speed changes and engine synchronization. With the speed selectors in the governing range, any force tending to slow the rotor system (such as increases in collective pitch) will be sensed by the fuel control unit, which will attempt to maintain constant N_r by increasing power.

ENGINE SPEED TRIM SWITCHES

The engine speed trim switches located on each collective pitch lever grip (figure 54), are used to make adjustments to power turbine speed and for engine synchronization. The switches are marked ENG TRIM, 1 and 2, + (plus) and - (minus). The switches provide electrical power to actuators, in the overhead control quadrant, which are connected to the speed selectors. The speed selectors are positioned by the actuators for adjustment to the desired power turbine speed. Moving the ENG TRIM switches forward will cause increases in power turbine speed, and moving the switches aft will cause decreases in power turbine speed. When the desired power turbine speed is attained, the switches are released and will return to the spring-loaded center position. The switches are capable of advancing the speed selectors from shutoff to the ground idle detent and, if manually removed from the detent, to the full forward

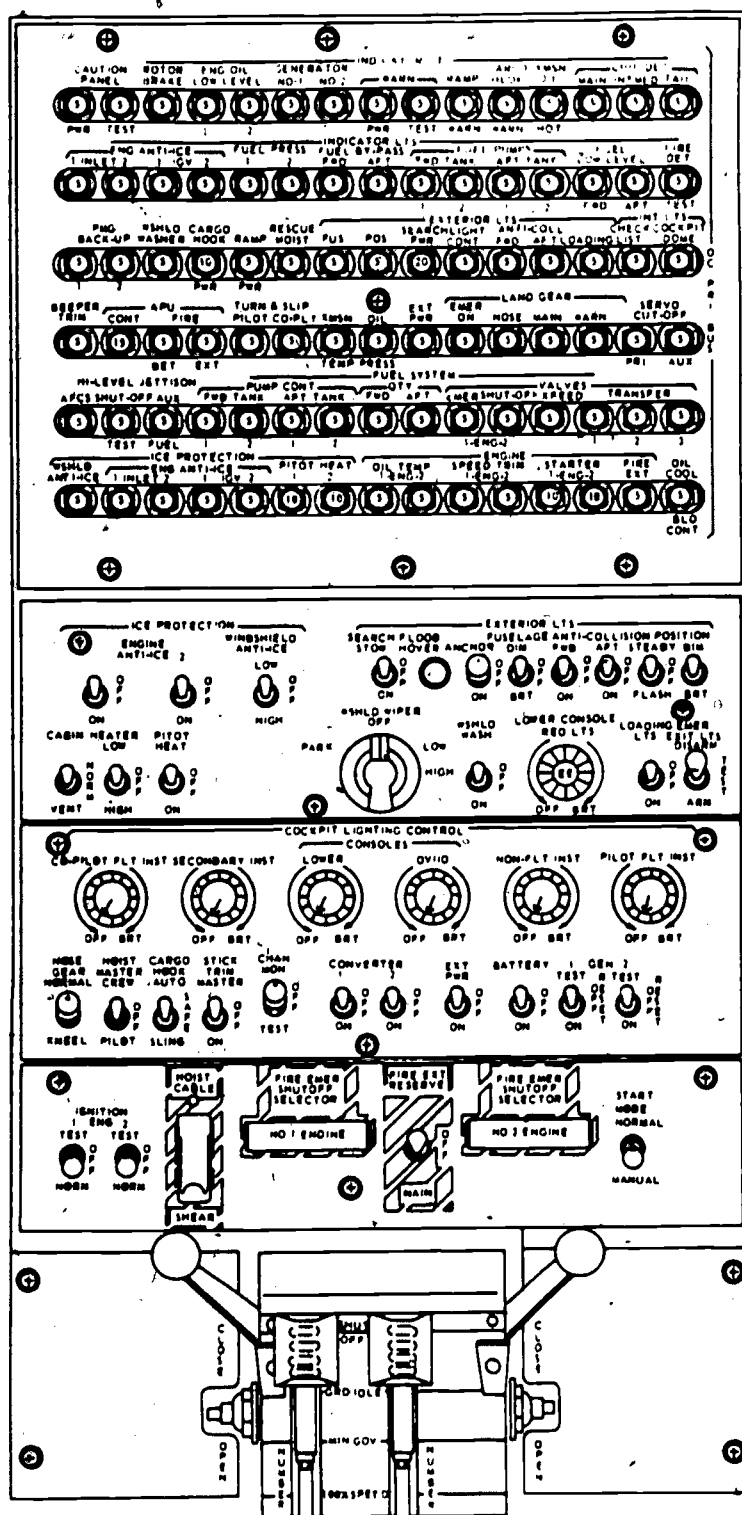


Figure 52. - Overhead engine control quadrant, switch panel, and DC circuit breaker panel.

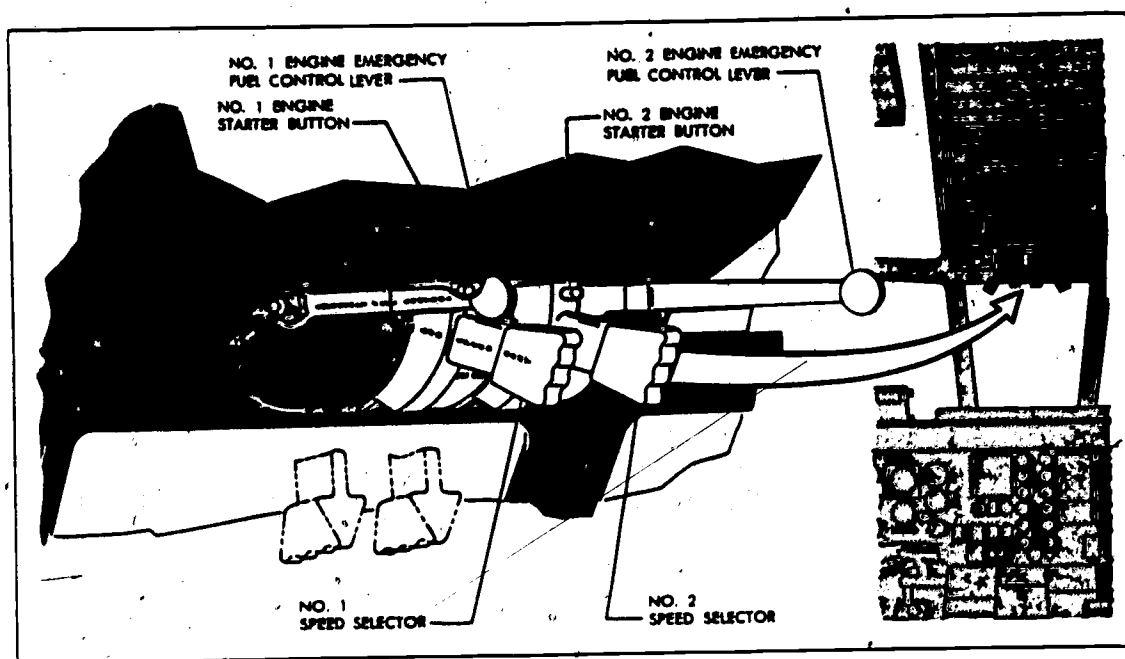


Figure 53. - Engine controls.

ward position. The switches are capable of retarding the speed selectors from full forward to $93 \pm 1\%$ N. The ENG TRIM switches receive electrical power from the DC primary bus through circuit breakers on the center overhead DC circuit breaker panel. The circuit breakers are under the general heading ENGINE (SPEED TRIM, 1-ENG-2).

EMERGENCY FUEL CONTROL LEVERS

Two emergency fuel control levers, one for each engine, marked EMER FUEL CONTROL, are located on each side of the engine control quadrant (figure 53). The emergency fuel control levers operate independently and are used in event of fuel control unit malfunction. Each emergency fuel control lever has positive stops (marked OPEN and CLOSE) and is connected directly, by a flexible cable and linkage, to the main metering valve in each engine fuel control unit. The primary function of the emergency fuel control lever is to manually override the automatic features of the fuel control. The emergency fuel control lever must be used with extreme caution as it has direct control of fuel flow. Misuse can cause engine over-speed or overtemperature.

The initial position of the fuel metering valve is dependent upon the automatic features of the fuel control as established

by the setting of the speed selector. The emergency fuel control lever is mechanically connected to a cam within the fuel control. This cam, when actuated by advancing the lever, contacts the fuel metering valve. Once contact is established, further advancement of the emergency fuel control will manually control fuel flow, which in turn regulates engine power output. The emergency fuel control is unable to reduce the position of the metering valve below that called for by the speed selectors. Control below this point will depend upon the type of malfunction encountered. In all instances of emergency fuel control operation, remember that the speed selectors must not be retarded beyond the GRD IDLE position. The fuel stop-cock is located downstream of the metering valve and is actuated by the speed selectors. Placing the speed selector in the SHUT-OFF position will stop engine fuel flow regardless of emergency fuel control lever position.

CAUTION

At high power settings considerable "dead band" travel will normally be encountered before the emergency fuel control lever becomes effective as indicated by a slight restriction in

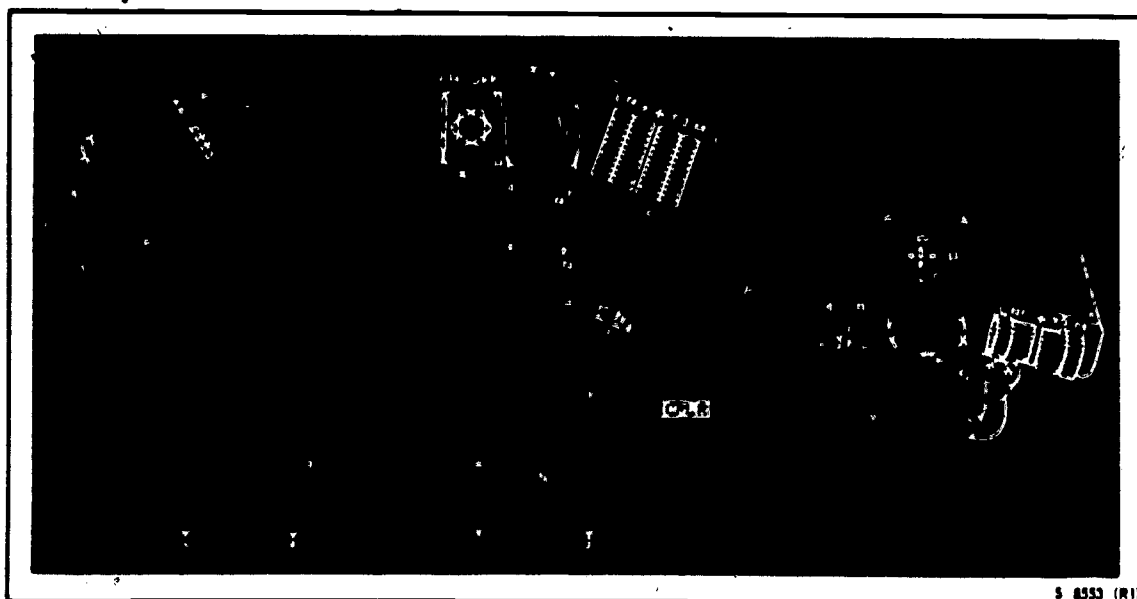


Figure 54. - Collective pitch lever grip.

control movement. When this is felt, the control will be very sensitive, and care should be taken not to exceed T_5 and N_g limits.

STARTER SYSTEM

The starting system consists of a starter, starter relay, start bleed valve, start fuel valve, starter button, mode selector switch, and abort switch. The system operates on 28 volts DC from the primary bus and is protected by circuit breakers, marked STARTER 1 ENG 2, located on the overhead circuit breaker panel. The engine starting system (figure 55) has two modes of operation: normal and manual. The normal mode provides a completely automatic start which includes automatic starter dropout after engine lite-off. The manual mode provides an alternate means of starting when external electrical power or the battery is used. In this mode, the automatic starter dropout feature is bypassed. In either mode, the start bleed valve operates automatically, and the auxiliary start fuel shutoff valve may be operated by the pilot.

The starter has a duty cycle limited to 30 seconds continuous cranking, a minimum cooling period of 3 minutes between

start attempts, and a maximum of three start attempts in any 30-minute period. Before the starter can be energized, APU, external, or battery power is required. During start, as the engine speed selector lever is advanced to the GRD IDLE position, the stopcock opens and allows fuel to pass through the flow divider and to enter the number one (low pressure) manifold to the nozzles where it is mixed with compressor discharge air. As the fuel-air mixture leaves the nozzles, it is ignited by the two igniter plugs in the combustion chamber and enters a sustained combustion process.

STARTER DROPOUT

Starter operation and dropout may be monitored by noting the magnetic compass heading before engine start. When the starter is energized, the compass will swing to a new heading. When normal start circuit is used, the starter will automatically drop out when starter amperage falls below 100 ± 15 amperes (45 to 53 percent N_g). The compass should then swing back to its original heading, signifying the starter has dropped out. When the manual start circuit is used, the starter will dropout only when the abort switch is actuated.

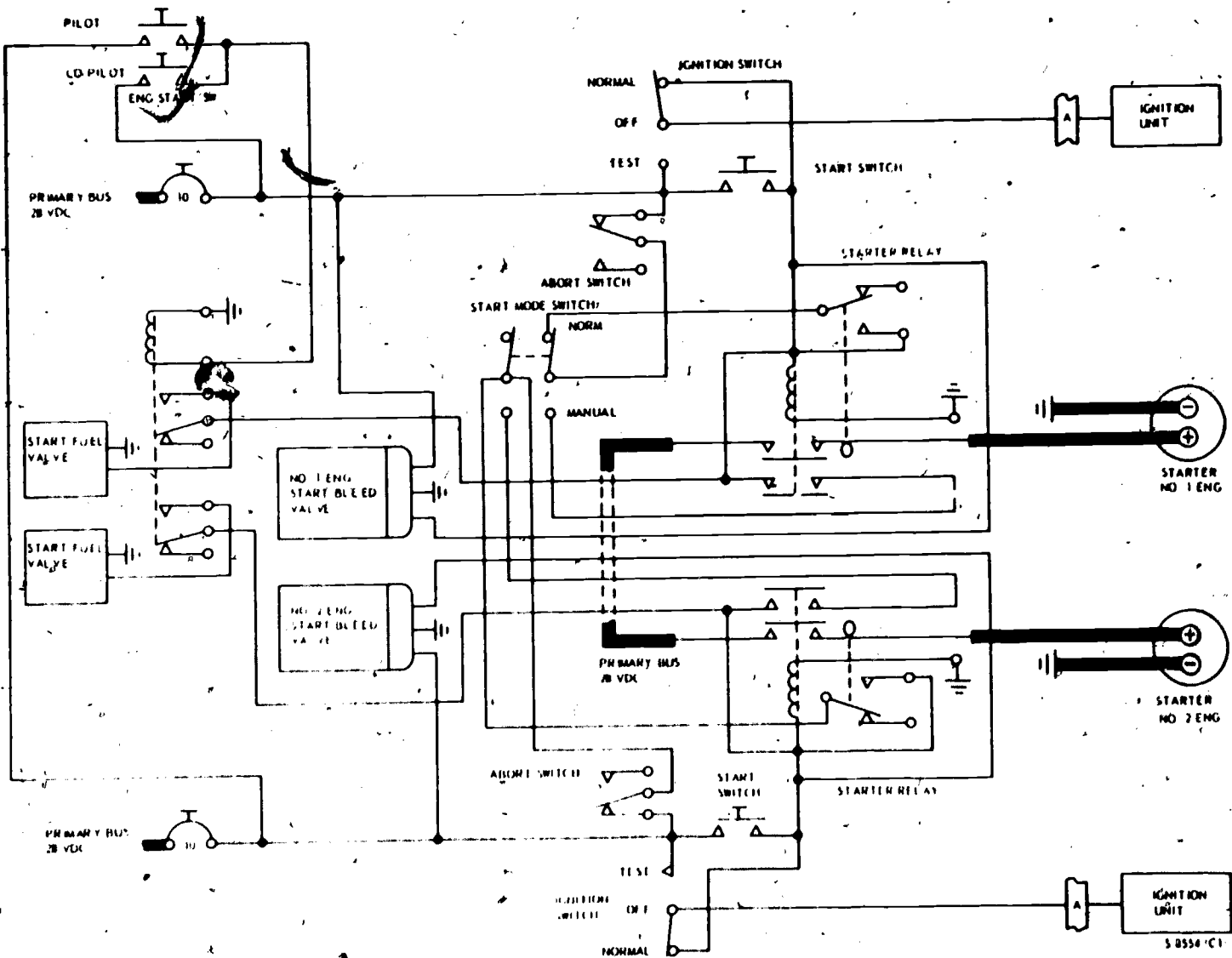


Figure 55. - Engine starting system.

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START BLEED VALVE

The start bleed valves, located on each engine, operate automatically during the start cycle and require no specific pilot action. The function of the valve is to raise the compressor stall line during the start cycle to increase the reliability of the start system. This is done by bleeding approximately 6.7 percent of the compressor discharge airflow at ground idle and by delaying the closing of the valve 3 to 7 seconds beyond the point where the starter, ignition circuit, and start fuel valve circuit are de-energized simultaneously. The bleed valve remains fully closed during all regimes of engine operation except during starting.

NOTE

On helicopters modified by TCTO 2J-T58-544, the time delay relay has been removed from the start bleed valve.

STARTER BUTTONS

A starter button is located on each speed selector lever. The starter is energized by holding the speed selector lever in the SHUT-OFF position and momentarily depressing the starter button. This energizes the starter relay and completes the circuit to the starter. When using normal starting mode, after engine lite-off and the electrical power load to starter decreases, the starter relay will automatically dropout, de-energizing the starter. When the manual mode is being used, the respective speed selector must be pulled down to actuate the abort switch, which in turn drops out the starter.

STARTER ABORT SWITCH

A starter abort switch is located in each speed selector lever. The switch is actuated by pulling down on the speed selector lever. This action breaks electrical circuit continuity to the ignition system and the starter relay.

MODE SELECTOR SWITCH

The mode selector switch, with marked positions MANUAL and NORMAL under the general heading START MODE, is located on the overhead control panel. When the switch is placed in the NORMAL position, the automatic dropout function of the starter relay is energized, allowing the starter to remain energized to 45 to 53% N_g. When the switch is placed in the MANUAL position, the automatic dropout feature of the starter relay is bypassed, allowing the starter to remain energized until the abort switch is actuated manually. The switch operates on 28 volts DC from the primary bus.

START FUEL VALVES

Two start fuel valves, one for each engine, are located in the engine compartment and are installed between the engine fuel control and flow divider. When the valve is actuated during the start cycle of either engine, the flow of auxiliary starting fuel is blocked. This blockage decreases the total amount of fuel flow during starting, thus diminishing the possibility of an overtemperature condition due to excessive fuel flow. The valves operate on 28 volts DC from the primary bus and are protected by the main starting circuit breakers.

Start Fuel Valve Switch

The push-button type start fuel valve switch, marked ENG ST, is located on each cyclic stick grip. In addition to depressing the switch, the pilot must close the starter relay for the engine to be started before the valve will operate. Either the pilot's or copilot's switch will control the operation of both valves. The switch operates on 28 volts DC from the primary bus.

IGNITION SYSTEM

Each engine ignition system consists of a capacitor-discharge ignition unit, two ignitor plugs, and a control circuit. The system provides ignition for starting only; during engine operation, the flame in the

combustion chamber is self-sustaining. The ignition system is mounted on the engine. The system is controlled by a three-position switch mounted on the overhead switch panel. When the switch is in the NORM position, the ignition unit operates in conjunction with the starter. The ignition system is de-energized when the starter is de-energized. The ignition system operates on current from the DC primary bus through the starter control system.

IGNITION SWITCHES

Two ignition switches, one for each engine, located on the overhead switch panel (figure 52), are marked IGNITION, 1 ENG, 2. Each switch has three marked positions, TEST, OFF, and NORM. The switches are normally in the NORM position. When the switch is in the NORM position with the starter engaged, the ignition unit is energized. Holding the switch in the spring-loaded TEST position energizes the ignition unit only. The TEST position is used (for ground operation only) without the starter to test the ignition circuit. A clicking can be heard when the switch is placed in TEST position. When the switch is in the OFF position, the ignition unit is de-energized. The engine may be motored by using the starter without ignition. The speed selector must be in the SHUT-OFF position before the starter and ignition systems can be energized.

ENGINE OPERATING INSTRUMENTS

TORQUEMETERS

Two torqueometers (1 and 45, figure 56), one for the pilot and one for the copilot, are located on the instrument panel. Each dual-pointer indicator, marked PERCENT TORQUE, contains two pointers, marked 1 and 2, which indicate input torque to the main transmission in percent of maximum engine power output of each engine. The electrically actuated torqueometer dials, calibrated in percent torque, are graduated in increments of 5 percent from 0 to 150 percent. The torqueometers operate on 26 volts AC and are protected by circuit breakers, marked 1 ENG TORQUE SENSOR, located on the copilot's AC circuit breaker

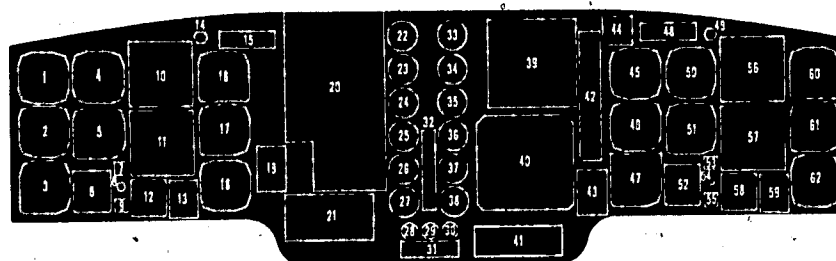
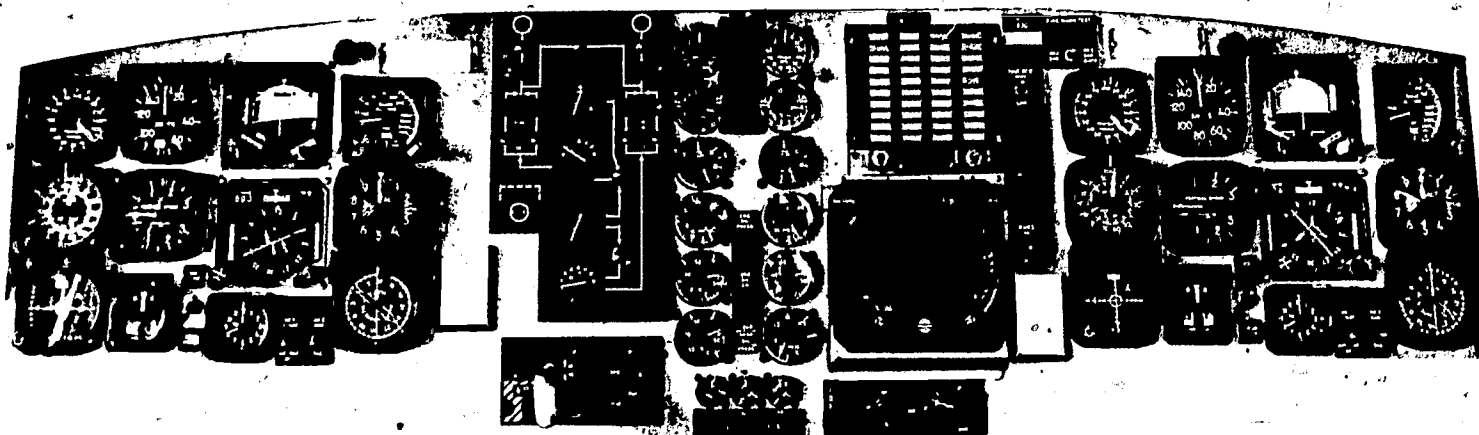
panel, and 2 ENG TORQUE SENSOR, located on the pilot's AC circuit breaker panel. The torqueometers indicate the amount of torque being applied to the main gear box by the engines. The torque sensing cells are located in the main gear box and are hydromechanical in nature, sensing any shift in the helical gear at the input from each engine. Oil pressures within the cells are sensed by pressure transmitters and transmitted electrically to the torqueometers.

ENGINE GAS GENERATOR (N_g) TACHOMETERS

Two engine gas generator tachometers (22 and 33, figure 56), one for each engine, are located on the instrument panel, and indicate the speed of the gas generator in percent rpm. Each tachometer has two dials and pointers. The outer dial and pointer indicates gas generator speed from zero to 100 percent, in increments of two percent. The small vernier dial and pointer, located in the upper left-hand position of the tachometer, indicates gas generator speed from zero to ten, in increments of one percent. The gas generator tachometer generator is driven by the engine oil pump shaft. The electrical power produced by the gas generator tachometer generator is proportional to gas generator rpm ($100\% N_g = 26,300$ gas generator rpm).

N_f AND N_r TRIPLE TACHOMETERS

Two triple tachometers (2 and 46, figure 56), one for the pilot and one for the copilot, are located on the instrument panel. Each tachometer contains three pointers: the pointers marked 1 and 2 indicate the power turbine speed (N_f) of the No. 1 and 2 engines, respectively; the pointer marked R indicates the main rotor rpm (N_r). The engine tachometers are powered by their own tachometer generators, which are driven by the power turbine through a flex cable. The cable is routed to the fuel control on which the generators are mounted. The main rotor tachometer is powered by its own tachometer generator, located on the accessory section of the gear box, and driven by the accessory gears. The tachometers are read in percent rpm ($103\% N_f = 19,500$ power turbine rpm and $103\% N_r = 210$ rotor rpm).



1. TORQUE INDICATOR
2. TRIPLE TACHOMETER
3. AFCS INDICATOR
4. AIRSPEED INDICATOR
5. VERTICAL VELOCITY INDICATOR
6. TURN AND SLIP INDICATOR
7. VOR SLAVE LIGHT
8. VOR SLAVE TACAN MASTER SELECTOR SWITCH
9. TACAN MASTER LIGHT
10. FLIGHT DIRECTOR
11. FLIGHT DIRECTOR
12. CLOCK
13. LF/AOF - VOR SELECTOR PANEL
14. MARKER BEACON LIGHT
15. AIRSPEED CORRECTION CARD
16. RADAR ALTIMETER
17. PRESSURE ALTIMETER
18. RADIO MAGNETIC INDICATOR (RMI)
19. COMPASS CORRECTION CARD
20. FUEL MANAGEMENT PANEL
21. LANDING GFAR CONTROL PANEL

22. GAS GENERATOR TACHOMETER
23. POWER TURBINE INLET TEMPERATURE INDICATOR
24. FUEL FLOW INDICATOR
25. ENGINE OIL PRESSURE INDICATOR
26. ENGINE OIL TEMPERATURE INDICATOR
27. TRANSMISSION OIL TEMPERATURE INDICATOR
28. UTILITY HYDRAULIC PRESSURE INDICATOR
29. AUXILIARY HYDRAULIC PRESSURE INDICATOR
30. PRIMARY HYDRAULIC PRESSURE INDICATOR
31. HYDRAULIC INDICATOR IDENTIFICATION PANEL
32. ENGINE INDICATOR IDENTIFICATION PANEL
33. GAS GENERATOR TACHOMETER
34. POWER TURBINE INLET TEMPERATURE INDICATOR
35. FUEL FLOW INDICATOR
36. ENGINE OIL PRESSURE INDICATOR
37. ENGINE OIL TEMPERATURE INDICATOR
38. TRANSMISSION OIL PRESSURE INDICATOR
39. CAUTION-ADVISORY PANEL
40. RADAR SCOPE
41. RADAR CONTROL PANEL
42. MARKER BEACON/RAWS CONTROL PANEL

S 8556 (C2)

43. COMPASS CORRECTION CARD
44. FIRE WARNING TEST PANEL
45. TORQUE INDICATOR
46. TRIPLE TACHOMETER
47. AFCS INDICATOR
48. AIRSPEED CORRECTION CARD
49. MARKER BEACON LIGHT
50. AIRSPEED INDICATOR
51. VERTICAL VELOCITY INDICATOR
52. TURN AND SLIP INDICATOR
53. VOR MASTER LIGHT
54. VOR MASTER/TACAN SLAVE SELECTOR SWITCH
55. TACAN SLAVE LIGHT
56. FLIGHT DIRECTOR
57. FLIGHT DIRECTOR
58. CLOCK
59. LF/AOF - VOR SELECTOR PANEL
60. RADAR ALTIMETER
61. PRESSURE ALTIMETER
62. RADIO MAGNETIC INDICATOR (RMI)

Figure 56. - Instrument panel.

POWER TURBINE INLET TEMPERATURE (T₅) INDICATORS

Two power turbine inlet temperature indicators (23 and 34, figure 56, marked EXH. TEMP, are located on the instrument panel. The indicators are graduated in degrees Centigrade and operate from thermocouples, located forward of the power turbine in the second-stage turbine casing, on each engine. The maximum power turbine inlet temperature is indirectly controlled by the gas generator speed adjustment of the fuel control.

ENGINE OIL PRESSURE INDICATORS

Two engine oil pressure indicators (25 and 36, figure 56), one for each engine, are located on the instrument panel. The indicators are powered by 26 volts AC from the auto-transformer and are protected by circuit breakers, marked OIL PRESS 1 ENG, on the copilot's AC circuit breaker panel and OIL PRESS 2 ENG on the pilot's AC circuit breaker panel. Pressure is indicated in psi.

ENGINE OIL TEMPERATURE INDICATORS

Two engine oil temperature indicators (26 and 37, figure 56), one for each engine, are located on the instrument panel.

ENGINE FIRE EXTINGUISHING SYSTEM

The engine fire extinguishing system (figure 57) consists of two charged containers of bromotrifluoromethane (CF₃Br), discharge nozzles, an overboard discharge tube, discharge indicator, necessary controls, and a relay. The CF₃Br containers,

in the aft main rotor fairing structure, are charged with CF₃Br, plus a nitrogen charge to propel the extinguishing agent into the engine compartment. Two fire extinguishing discharge tubes are on the center firewall near the compressor section of the engine, and two more discharge tubes are on the vertical firewall, aimed at the power turbine section of the engine.

The fire extinguisher system controls, on the overhead control panel, are used to energize the fire extinguisher system. When either FIRE EMER SHUT OFF SELECTOR NO. 1 ENGINE or FIRE EMER SHUT OFF SELECTOR NO. 2 ENGINE handle is pulled, it shuts off fuel flow to that engine and completes the circuit to the FIRE EXT switch on the overhead control panel. When the FIRE EXT switch is placed in the MAIN position, the electrical current from the FIRE EXT circuit breaker, through the FIRE EMER SHUT OFF SELECTOR handle, fires a cartridge within the container, permitting the CF₃Br to enter the engine compartment. If the fire has not been extinguished by the first discharge, placing the switch in the RESERVE position causes discharge of the other container. The system is wired so that when the FIRE EXT switch is placed in the RESERVE position, the remaining container will be fired into the engine compartment whose FIRE EMER SHUT OFF SELECTOR handle has been pulled.

A safety outlet in each container is connected to the red THERMAL DISCHARGE INDICATOR on the lower left side of the fuselage. If container pressure becomes excessive, due to thermal expansion, the fusible plug melts, the THERMAL DISCHARGE INDICATOR seal is ejected, and the extinguishing agent is discharged overboard. A pressure gage on each container facilitates a preflight pressure versus temperature check. Electrical power for the fire extinguishing system is supplied by the DC PRI bus.

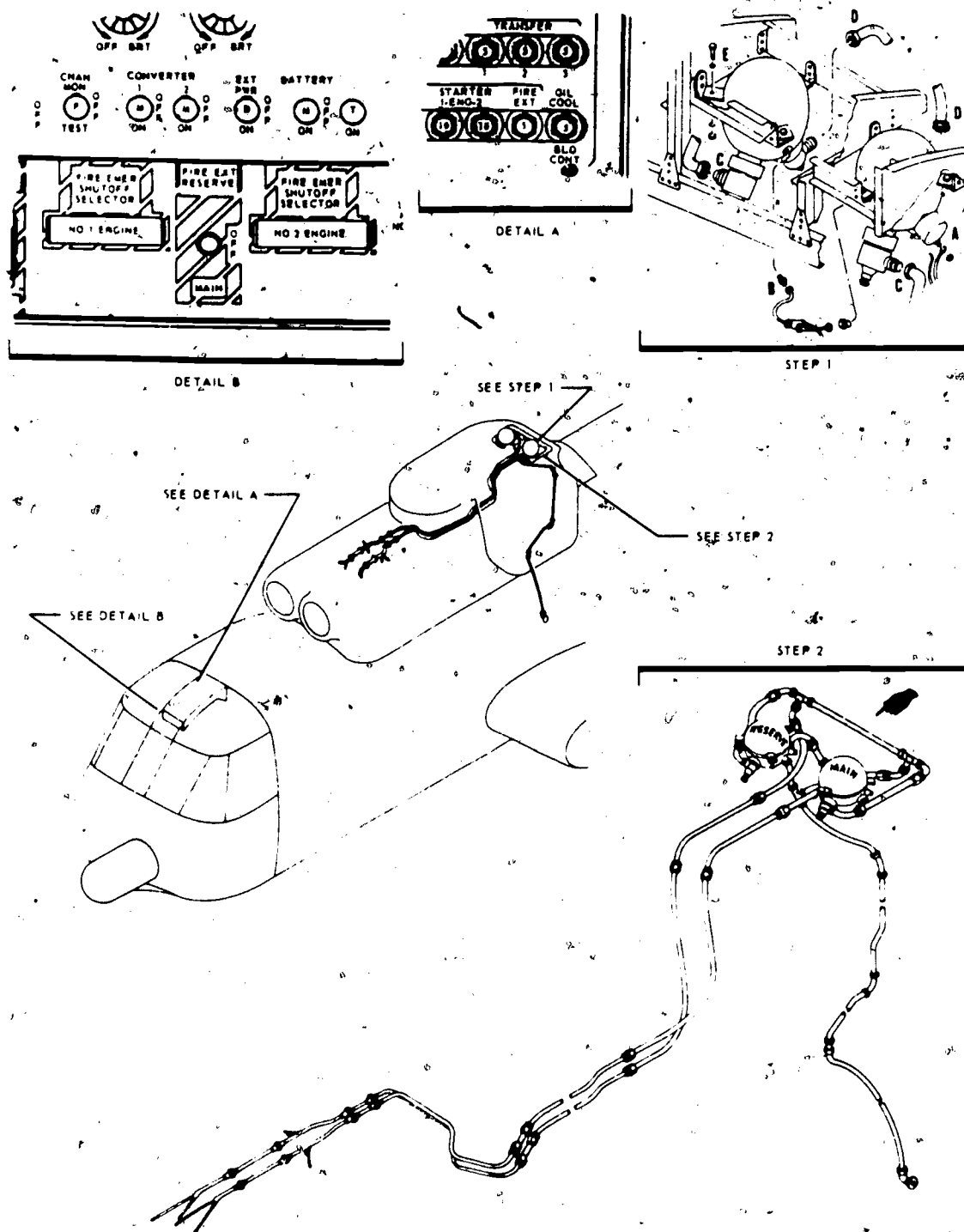


Figure 57. - Engine fire extinguishing system.

TABLE 1. Engine Wash and Rust Lick Procedures.

ENGINE WASH/RUST LICKING PROCEDURES

MINIMUM CREW 2 COCKPIT OPERATORS
1 FIRE GUARD
1 WASH/RUST LICK OPERATOR

PREFLIGHT

1. ENGINE INTAKE & EXHAUST COVERS - re-moved
2. ENGINE ACCESS DOORS - closed
3. APU INTAKE & EXHAUST - clear
4. APU ACCESS DOOR & WORK PLATFORM - closed
5. WHEEL CHOX - in place

STARTING CHECKLIST (#1-3 for night only)

1. BATTERY SWITCH - on
2. COCKPIT LIGHTING CONTROL - 7 rheostats full
3. PILOTS OVERHEAD MAP LIGHT - on & positioned

NORMAL DAYTIME PROCEDURES

4. OVERHEAD CIRCUIT BREAKERS - set
5. ENG ANTI-ICE - off
6. WINDSHIELD ANTI-ICE - off
7. SEARCH LIGHT - off
8. ANCHOR LIGHTS - off
9. FUSELAGE LIGHT - off
10. ANTI-COLLISION LIGHTS (2) - off
11. POSITION LIGHTS - off
12. CABIN HEATER - off & normal
13. PITOT HEAT - off
14. WINDSHIELD WIPERS - off
15. WINDSHIELD WASHER - off
16. LOADING LIGHT - off
17. EMERG LIGHT - arm
18. NOSE GEAR - normal/kneel
19. HOIST MASTER - off
20. CARGO HOOK - off
21. STICK TRIM MASTER - on
22. channel monitor - off
23. CONVERTERS (2) - on
24. EXT PWR - off
25. BATTERY - on
26. GENERATORS (2) - on
27. IGNITION (2) - off
28. HOIST CABLE - off and closed
29. FIRE EMER SHUTOFF SELECTORS (2) - in
30. FIRE EXT - off
31. START MODE - normal
32. EMERG FUEL CONTROL LEVERS (2) - ck & closed

33. ENGINE SPEED SELECTORS (2) - ck & closed
34. ROTOR BRAKE - on min press 320 psi
35. GEAR HANDLE - down 3 green lights
36. PARKING BRAKE - set
37. RAMP MASTER - off
38. APU FUEL SHUTOFF - normal
39. APU FIRE EXTING - off
40. APU START/RUN SWITCH - run
- CK FOLLOWING LTS ON - high exch temp & ovspd
- PRESS TO TEST - low oil press, prime pump press and fire warning
41. FIREGUARD - posted (in position)
42. APU START/RUN SWITCH - start position until Ng passes 45% then release to run
43. APU CLUTCH ENGAGEMENT - 76-80% Ng
44. HYDRAULIC PRESS INST. (3) - press up
45. WARNING LIGHTS - tested following lights must be out - CONV GEN PRI & AUX HYD PRESS XMISSION OIL PRESS & XMISSION CHIP DET
46. WASH OPERATOR - alerted
47. STOP CLOCK - start
48. STARTER #1 ENGINE - engaged
49. START WATER IN - indication of Ng continue water wash 10 seconds
50. STARTER #1 ENGINE - abort
51. continuing water wash but not greater than 25 seconds elapsed time on starter
52. REPEAT STEPS 47-50 for #2 ENGINE
53. WAIT MINIMUM OF THREE (3) MINUTES BEFORE PROCEEDING
54. IGNITION SWITCHES (2) - on
55. LOW PRESS WARNING LIGHTS (2) - press-to-test
56. FUEL SHUT OFF VALVE switches (2) - on

NOTE

Turn on outside boost pump switches (No. 1 FWD and No. 2 AFT) on odd dates, and the inside switches (No. 1 AFT and NO. 2 FWD) on even days.

57. FUEL BOOST PUMPS (2) - on
58. ALERT FIRE GUARD #1 ENGINE
59. STOP CLOCK - start
60. STARTER #1 ENGINE - engaged
61. SPEED SELECTOR - ground idle w/T5 less than 100°C (control T5 with start fuel valve on cyclic)
62. STARTER DROP OUT - compass swings approx. 49% Ng
63. CHECK FOR FOLLOWING READINGS:
 - a. Ng - 53-59%
 - b. T5 - 300 - 560° C

- c. FUEL FLOW - 130 pph
- d. ENGINE OIL PRESS - Min of 10 psi
- 64. REPEAT STEPS 58-64 for #2 ENGINE
- 65. RUN ENGINES FOR THREE (3) MINUTES
- 66. SPEED SELECTOR #1 ENGINE - stopcock
- 67. SPEED SELECTOR #2 ENGINE - stopcock
- 68. (Ensure T5 drops below and stays below 260 C after stopcocking)
- 69. OPEN ENGINE COMPARTMENT WORK PLATFORMS
- 70. FUEL BOOST PUMPS (2) - off
- 71. FUEL SHUTOFF VALVE SWITCHES (2) - off
- 72. IGNITION SWITCHES (2) - off
- 73. BEFORE PROCEEDING - do not attempt rust licking until T5 is less than 100°C - starter may be used to reduce T5 within limits
- 74. ALERT RUST LICK OPERATOR #1 ENGINE (if T5 100°C or less)
- 75. STARTER #1 ENGINE - engaged
- 76. MOTOR #1 ENGINE FOR 20 SEC - abort starter
- 77. STARTER #2 ENGINE - engaged
- 79. MOTOR #2 ENGINE FOR 20 SEC - abort starter
- 79. EMERG LIGHT - disarm
- 80. APU START/RUN SWITCH - off
- 81. COCKPIT LIGHTING CONTROL - 7 rheostats closed
- 82. STICK TRIM MASTER - off
- 83. CONVERTERS (2) - off
- 84. GENERATORS (2) - off
- 85. PILOTS OVERHEAD MAP LIGHT - off
- 86. COCKPIT DOME LIGHT - off
- 87. BATTERY SWITCH - off

LIMITATIONS

STARTER

- 30 seconds continuous load
- 3 minutes between each attempt
- 3 starts in 30 minutes

Ng

- 19% fuel boost pump operation minimum for start
- Approx. 49% Ng starter drop out
- 53-59% ground idle
- NO INDICATION - abort

T5

- 100°C or less for start or rust licking
- 720°C hot start - abort
- 300-560°C normal at ground idle
- 300°C continuous temp after eng has been stopcocked - indicates internal fire

TIME

- 7 seconds - engine light must occur within 7 sec after adv to grnd idle

FIRE PROCEDURES

- (*all cockpit indications are to be confirmed by fire guard before extinguishing agents*)

APU COMPT

- 1. APU EMERG FUEL SHUTOFF SWITCH - off
- 2. APU FIRE EXTING SWITCH - fire extng
- 3. APU MASTER SWITCH - off

ENGINE COMPARTMENT FIRE

- 1. SPEED SELECTOR - stopcock
- 2. FIRE EMERG SHUTOFF SELECTOR - pull T-handle this will select compt that extinguisher will be fired into and shut off fuel
- *3. FIRE EXTINGUISHER SWITCH - main
- 4. FUEL SHUTOFF VALVE SWITCH - closed
- 5. BOOST PUMP SWITCHES - off
- 6. ENGINE INSTRUMENTS - check T5 for rises - if above 300°C proceed with engine post-shutdown fire checklist

ENGINE POST-SHUTDOWN FIRE

(T5 300°C or above)

- 1. IGNITION SWITCHES - off
- 2. SPEED SELECTORS - stopcock
- 3. STARTER BUTTON - depress - motor starter until T5 drops to below 200°C

IF FIRE PERSISTS

- 4. FIREGUARD - discharge into air inlet duct while motoring engine
- 5. SPEED SELECTOR - abort starter
- 6. IF FIRE WARNING LIGHT IS ON
 - a. FIRE EMERG SHUTOFF SELECTOR HANDLE - pull
 - *b. ENGINE FIRE-EXTING SWITCH - main
- 7. TURN OFF ALL SWITCHES AND EXIT AIRCRAFT

REVIEW

In this section we have discussed the T58-GE-5 engine. This is a very dependable engine, but it should be given a good preflight and postflight.

(Now answer the following review questions.)

45. Variations in power requirements to maintain constant free turbine speed are accomplished by _____.

- A. bleed-off of compressor discharge airflow
- B. movement of the inlet guide vanes
- C. automatic increases or decreases in gas generator speed
- D. changes in air pressure and air temperature

45.C (Refer to page 67)

46. The start bleed valve remains open for _____ seconds after starter dropout.

- A. 3 to 7
- B. 3 to 9
- C. 4 to 7
- D. 6 to 7

46.-A This does not apply to engines that have been modified by T.C. T.O. 2J-T58-544. (Refer to page 67)

47. Which components below are located within the fuel control unit?

- 1. Fuel filter
 - 2. Fuel flow divider
 - 3. Start fuel valve
 - 4. Main metering valve
 - 5. Pressure regulating valve
- A. 1, 2, and 3 only
 - B. 1, 4, and 5 only
 - C. 2, 3, 4, and 5 only
 - D. 1, 2, 3, 4, and 5

47.-B (Refer to page 71)

48. The ground idle position of the speed selector is approximately _____ %.

- A. 53%
- B. 54%
- C. 55%
- D. 56%

48.-D (Refer to page 71)

49. During operation of the emergency fuel control levers, actuating the normal speed selectors to the shutoff position will _____.

- A. allow full emergency operation
- B. stop all fuel flow to the engine
- C. reduce the fuel metering to the engine
- D. increase the fuel metering to the engine

49.-B (Refer to page 73)

50. When the normal start circuit is used, starter dropout will occur at _____ percent Ng.

- A. 43 to 53
- B. 43 to 55
- C. 45 to 53
- D. 45 to 56

50.-C (Refer to page 74)

51. The ignition switch is located on the _____.

- A. pilot's cyclic stick
- B. instrument panel
- C. overhead switch panel
- D. pilot's collective stick

51.-C (Refer to page 77)

52. The pilot's and copilot's torque- meters operate on _____ power.

- A. 26 VDC
- B. 26 VAC
- C. 28 VDC
- D. 28 VAC

52.-B (Refer to page 77)

53. If the FIRE EXT switch were placed in the MAIN position with neither of the FIRE EMER SHUTOFF SELECTOR handles pulled, what, if anything would happen?

- A. The MAIN bottle would be discharged into the last selected engine
- B. The circuit breaker would pop
- C. The MAIN bottle would be discharged into the thermal discharge tube
- D. Nothing

53.-D (Refer to page 79)

54. During the rust lick operation, the engine is motored for a total of _____ seconds.

- A. 10
- B. 19
- C. 20
- D. 30

54.-C (Refer to page 82)

GROUND HANDLING AND SERVICING

OBJECTIVES

When you complete this section, you will be able to:

1. Describe the ground handling procedures for the HH-3F.
2. Summarize the servicing procedures for the HH-3F.

GROUND HANDLING

TOWING

Towing includes procedures necessary to manipulate the helicopter on the ground or in the water. (See figure 58.) Before towing the helicopter, all personnel should familiarize themselves with towing precautions.

Towing Precautions.

WARNING

Failure to observe any of these safety precautions may result in damage to helicopter or injury to personnel.

NOTE

To prevent damage to the helicopter compass system: when moving the helicopter within the first five minutes after helicopter shut-down, APU power must be applied and abrupt helicopter movements avoided. After twenty minutes, the helicopter may be moved with no damage to the compass system. Under no circumstances shall the helicopter be moved between 5 and 20 minutes after the helicopter's electrical power has been secured.

CAUTION

Do not drag floats on ground if necessary to move helicopter with floats inflated.

1. Do not tow the helicopter on land while engines or main rotor blades are in operation.
2. Make sure that controls are attended by qualified helicopter personnel, that brakes are in good operating condition, and that brake system pressure is built up by pumping brake pedals.
3. Make sure the helicopter is moving before turning the nose gear.

4. Never tow the helicopter faster than 5 mph and avoid quick starts and stops.

5. Avoid, when possible, braking to stop in turns at any towing speed. Damage to nose landing gear may result.

6. When towing helicopter near obstacles, station personnel near obstacles to prevent collision.

7. Make sure all personnel are clear of the helicopter before taxi or tow operations.

8. Move all equipment from the intended helicopter path and, whenever possible, avoid congested areas.

9. Remove wheel chocks only when ready to tow.

10. Never tow or back the helicopter over rough ground or steep grades using nose landing gear tow bar.

Nose Landing Gear Towing (See figure 58.)

CAUTION

To prevent damage to nose landing gear components, do not tow with nose landing gear in kneeled position. Do not release PARKING BRAKE until tow bar is secured between helicopter and tow vehicle.

1. Disconnect the low-resistance static ground strap if it is connected.
2. Insert tow bar (T-29) pins into towing points and secure with locking bar.
3. Release the lock and push down on the PARK LOCK handle; rotate nose gear with tow bar just enough to remove any side load

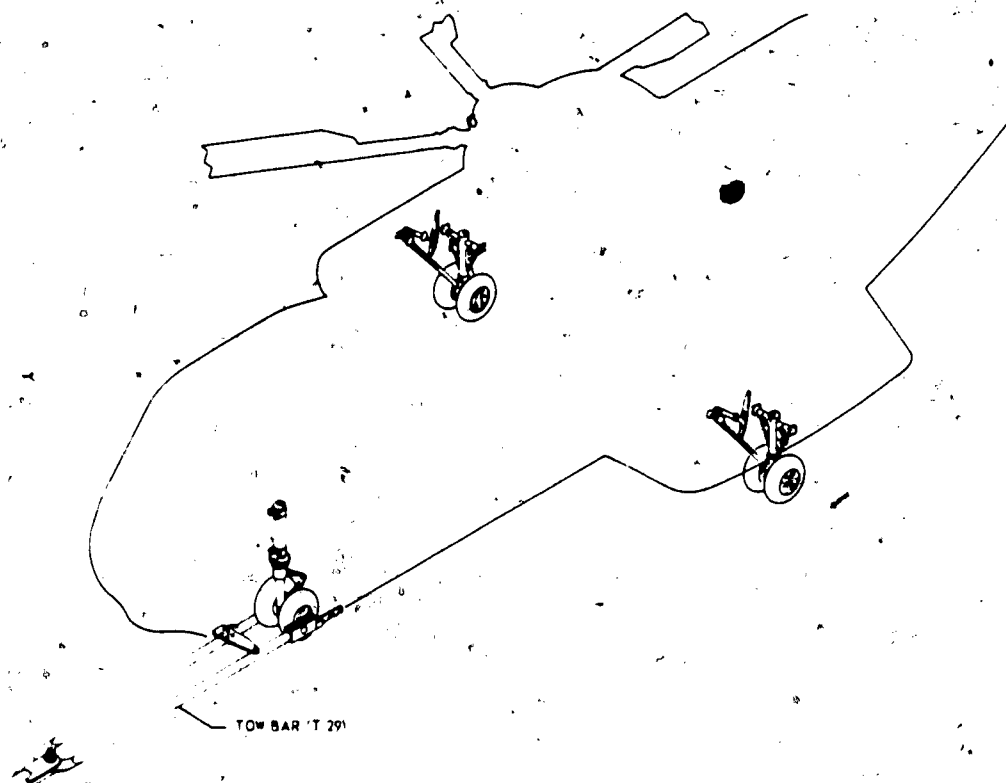


Figure 58. - Ground towing.

on lockpins. Check for complete lockpin retraction by moving nose landing gear in both directions.

4. Connect the tow bar (T-29) between tow vehicle and helicopter.

5. Make sure all mooring lines are disconnected.

6. Hold the PARKING BRAKE handle while releasing it, by depressing brake pedals. Remove chocks and proceed with towing operation.

Main Landing Gear Towing

Under emergency conditions, towing may be done by attaching cables, or other similar equipment, to tow rings on the aft portion of the main landing gear struts and positioning the tow vehicle aft of the helicopter.

1. Attach tow cables, or other similar equipment, to main landing gear.

2. Release the lock and push down on the PARK LOCK handle; check to see that lockpin is completely retracted by rotating nose gear with tow bar in both directions.

3. Hold PARKING BRAKE handle while releasing it, by depressing brake pedals.

4. Make sure all mooring lines are disconnected.

5. Remove chocks and perform emergency towing operation.

Emergency Water Towing

Under emergency conditions, the helicopter may be towed in a forward direction on the water.

CAUTION

To prevent excessive rolling and possible upset, do not tow helicopter in rearward direction.

NOTE

These procedures are provided as a guide only. Deviations are permitted to suit a specific situation.

1. Inflate emergency flotation bags, if not previously done.
2. Lower landing gear to lower center of gravity of helicopter.

PARKING AND MOORING - GENERAL

Accessibility requirements for maintenance and servicing normally determine the position for parking and mooring the helicopter. However, prevailing wind direction and speed, gusts and frequency of gusts, proximity of other aircraft and buildings, and gross weight of the helicopter must be taken into account. Generally, the following referenced instructions are applicable under the circumstances indicated. Local conditions, however, must be overriding factors when you are determining action to be taken.

Parking

1. Locate the helicopter more than rotor blade distance from other helicopters or objects. If wind speeds of less than 20 knots are expected and the helicopter is to stand for a short period of time, park the helicopter for ease of maintenance and servicing. If wind speeds of 20 knots or more are expected, park the helicopter facing into the wind.
2. Install main landing gear safety pins (T-12) (step 1, figure 59).
3. Apply the rotor brake and check to see that the pressure gage (step 2) indicated minimum of 320 psi pressure.

4. Lock the rotor brake handle in the engaged position, using latch (step 2).

5. Center the nosewheel and pull up on the PARK LOCK handle (step 3).

6. Depress brake pedals and pull up on the PARKING BRAKE handle to lock parking brakes (step 4).

7. Chock the main wheels (step 5).

8. Ground the helicopter using the ground strap.

9. Cover the cockpit windshield with windshield protector (T-6), if necessary.

Mooring

Helicopters tied down as directed can withstand winds up to 65 knots. (See figure 154.)

CAUTION

Evacuate helicopter to a safe weather area or store in a hangar when a tornado, hurricane, or wind above 65 knots is expected.

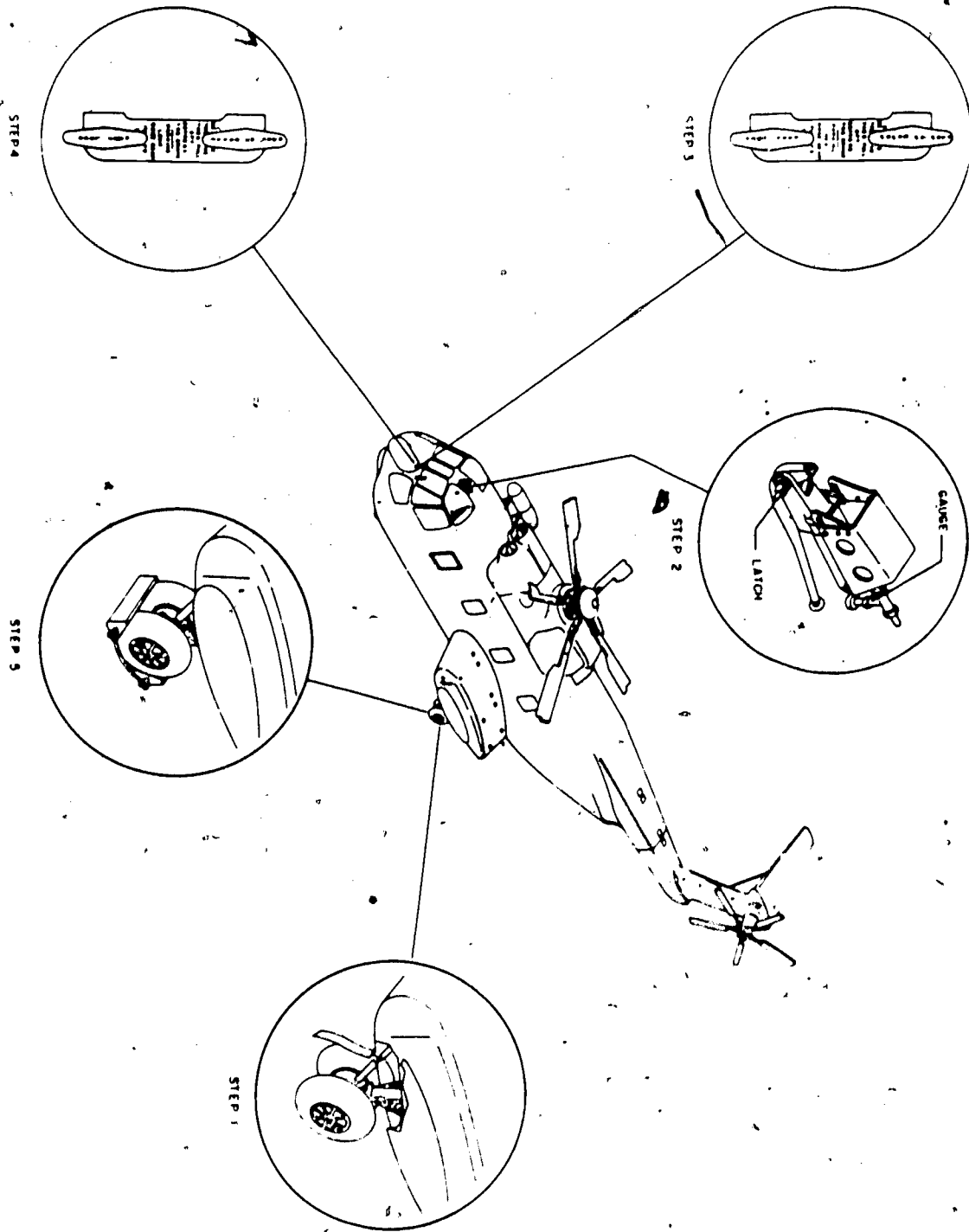
1. Park the helicopter in accordance with procedures in the previous Parking section.
2. Chock the nose wheels.
3. If wind speeds above 30 knots are expected, nail the wood cleats from chock to chock on each side of the main and nose wheels. Use a rope if wood cleats are not available, or when using ice grip chocks.

CAUTION

Use extra care when removing blades in winds higher than 30 knots.

4. To equalize weight on both sides of the helicopter, rotate the main rotor head to position one blade over aft fuselage, and engage rotor brake. When high winds are forecast, and time permits, it may be desirable to remove main rotor blades.

Figure 59. - Parking.



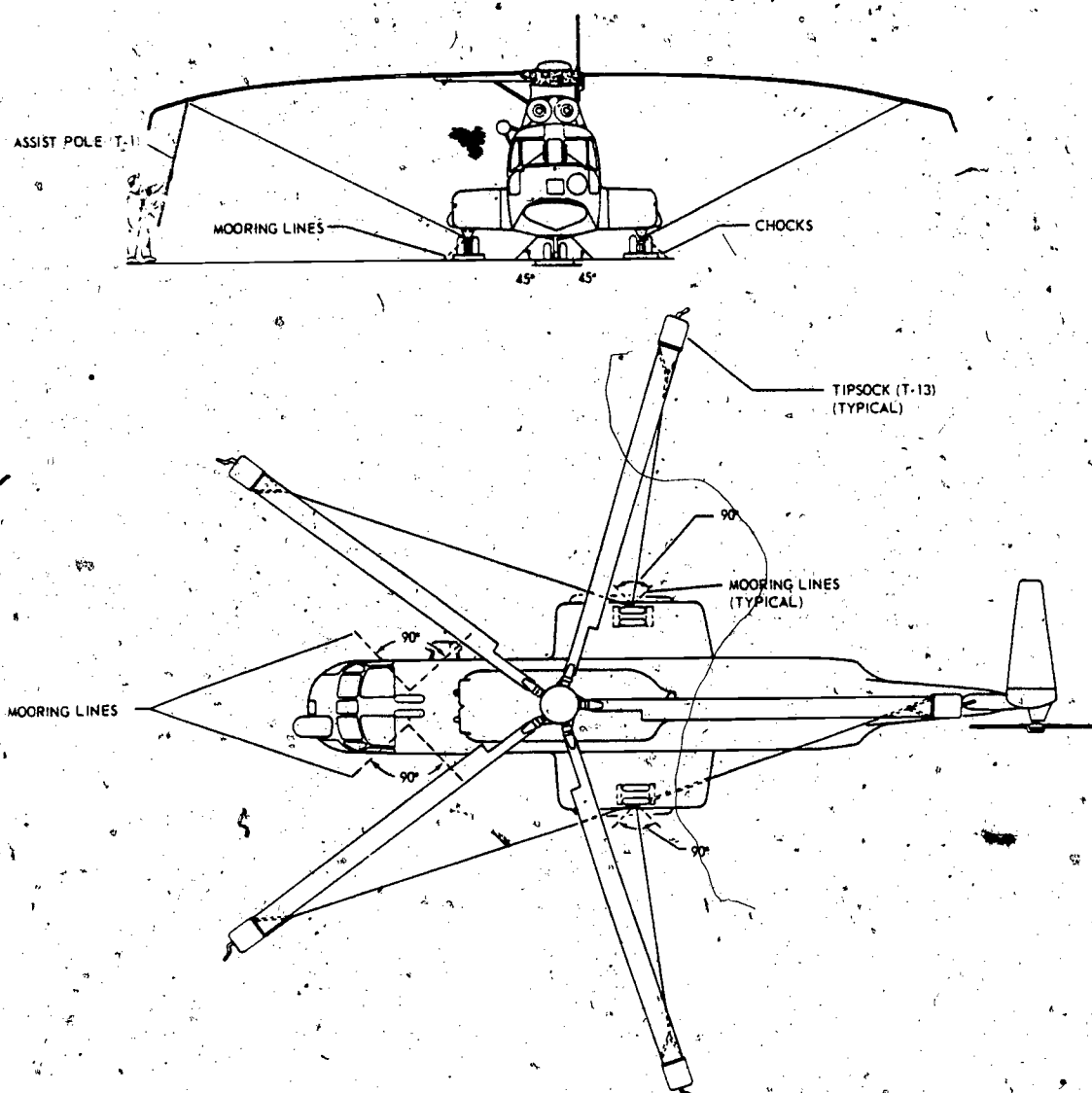


Figure 60. - Mooring.

5. Install blade tiedown tip sock (T-13), using assist pole (T-1).

CAUTION

To prevent damage to blades, avoid excessive tightening of tiedown lines. At no time should tiedown deflection of blades tips exceed 4 feet from static position.

6. Secure the end of each blade tiedown line to nearest landing gear tiedown ring.

Normally, lines should be tightened to deflect blade tips 6 inches downward from static position.

7. Secure the mooring lines from nose and main gear tiedown rings to tiedown fittings or anchors in accordance with figure 154. If wind speeds above 30 knots are expected, use 5/16-inch aircraft cable. If cable is not available, three chains with a 3,000-pound pull test each or two lines of 3/4-inch manila rope may be used.

8. Secure all maintenance stands and loose equipment.

9. After high winds, check helicopter for damage from flying objects and buffeting.

Cold Weather Parking And Mooring

1. Avoid wet or slushy areas when parking the helicopter.
2. To prevent tires from freezing to ground, clear snow from the parking area and place tires on insulating material.
3. To prevent rupturing of diaphragm seals in the main rotor head on next engagement, tie down blades in full lag position.
4. After the helicopter is moored securely, release the parking brakes to prevent freezing in locked position.

CAUTION

Use of de-icing fluid containing methyl-alcohol is prohibited.

5. If helicopter surfaces are wet, dry them and install protective covers when the helicopter is to be parked for more than one-half day at below freezing temperatures and the danger of precipitation exists. Surfaces may be covered with a thin film of de-icing fluid (C-2) to prevent covers from freezing to the helicopter.

6. Place covers over landing gear wheels to prevent snow or rain from entering brakes and subsequently freezing.

COLD WEATHER GROUND CHECK/DE-ICING

Check the entire helicopter for snow, frost, and ice accumulation.

NOTE

Snow, frost, or light ice can be removed from aircraft and rotor blades by normal runup.

CAUTION

Do not chip off ice or snow, as damage to helicopter may result. Use brush as an alternate method.

PROTECTIVE COVERS AND ENGINE PLUGS

Protective covers are provided for use during stowing or parking to keep precipitation, dirt, dust, etc., out of the helicopter and to protect the main rotor head, tail rotor head, windshield, engines, main rotor blades, and tail rotor blades. In addition, covers are provided to seal the pylon; engine plugs are provided for the engine air intake and exhaust; and shields are provided for the APU inlet and exhaust. For an illustrated listing of protective covers and engine plugs, see figure 61).

GROUND SAFETY LOCKS AND PINS

Ground safety pins (T-12) are provided for the main landing gear strut to prevent accidental retraction while the aircraft is on the ground. (See step 1, figure 59.) The nose landing gear is fitted with a safety lockpin, controlled by the PARK LOCK handle. (See step 3.) The nosewheel safety lockpin prevents the wheel from pivoting when the helicopter is parked.

SERVICING

GENERAL

Servicing includes checking, filling, and draining various helicopter components. Detailed instructions are provided in servicing and draining diagrams and in tables 2, 3, and 4. Servicing instructions not covered by these diagrams and tables are covered under the appropriate titles as necessary.

AIRFRAME GROUP SERVICING

Servicing requirements for airframe group systems and components are contained

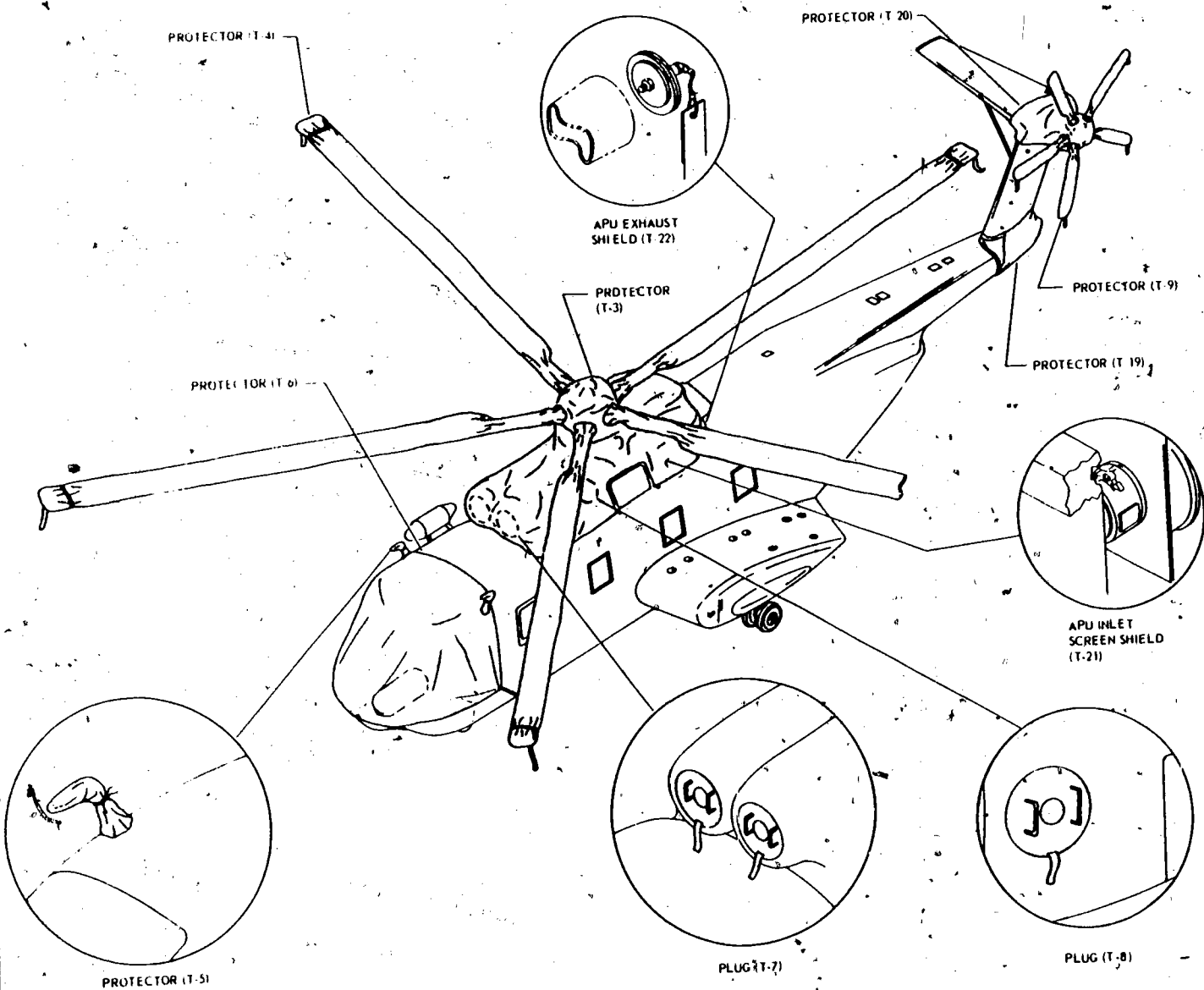


Figure 61. - Protective covers and engine plugs.

in figures 62, 63, and table 2. Additional servicing instructions are covered under the appropriate titles.

TABLE 2

CONSUMABLE MATERIALS REQUIRED

WARNING

Observe all cautions and warnings on the containers when using consumables. When applicable, wear necessary protective gear during handling and use. If a consumable is flammable or explosive, MAKE CERTAIN consumable and its vapors are kept away from heat, spark, and flame. MAKE CERTAIN helicopter is properly grounded and fire-fighting equipment is readily available before use. For additional information on toxicity, flashpoint, and flammability of chemicals, refer to T.O. 42C-1-9 or NA 07-1-505.

ITEM NO. C-	NOMENCLATURE	PART NO. (MFR'S DESIGNATION)
1	Anti-freeze, Ethylene Glycol, Inhibited	Federal Specification O-A-548
2	Fuel, Aircraft Turbine and Jet Engine, Grade JP-5	Military Specification MIL-J-5624
3	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance	Military Specification MIL-H-5606 (NATO H-515)

3A	Inhibitor, Fuel System-Icing	Military Specification MIL-I-27686E
4	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	Military Specification MIL-L-7808 (NATO O-148)
5	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	Military Specification MIL-L-23699 (NATO O-156)
6	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	ESSO TURBO 35 (NATO O-149)
7	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	SHELL 750 (NATO O-149)
8	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	TEXACO STATO-35 (NATO O-149)
9	Lubricating Oil, Internal-Combustion Engine, Preservative	Military Specification MIL-L-21260 Type 1, Grade, 30 NATO C-642)
9A	Lubricating Oil, Internal-Combustion Engine, Preservative	Military Specification MIL-L-21260 Type 1, Grade 50
10	Lubricating Oil, General Purpose, Low Temperature	Military Specification MIL-L-7870 (NATO O-142)
10A	Nitrogen, Technical	Federal Specification BB-N-411C Type 1, Class 1, Grade A or B
11	Silicone Fluid, Dimethyl Polysiloxane	Military Specification VV-D-001078 (100 Centistoke Viscosity)

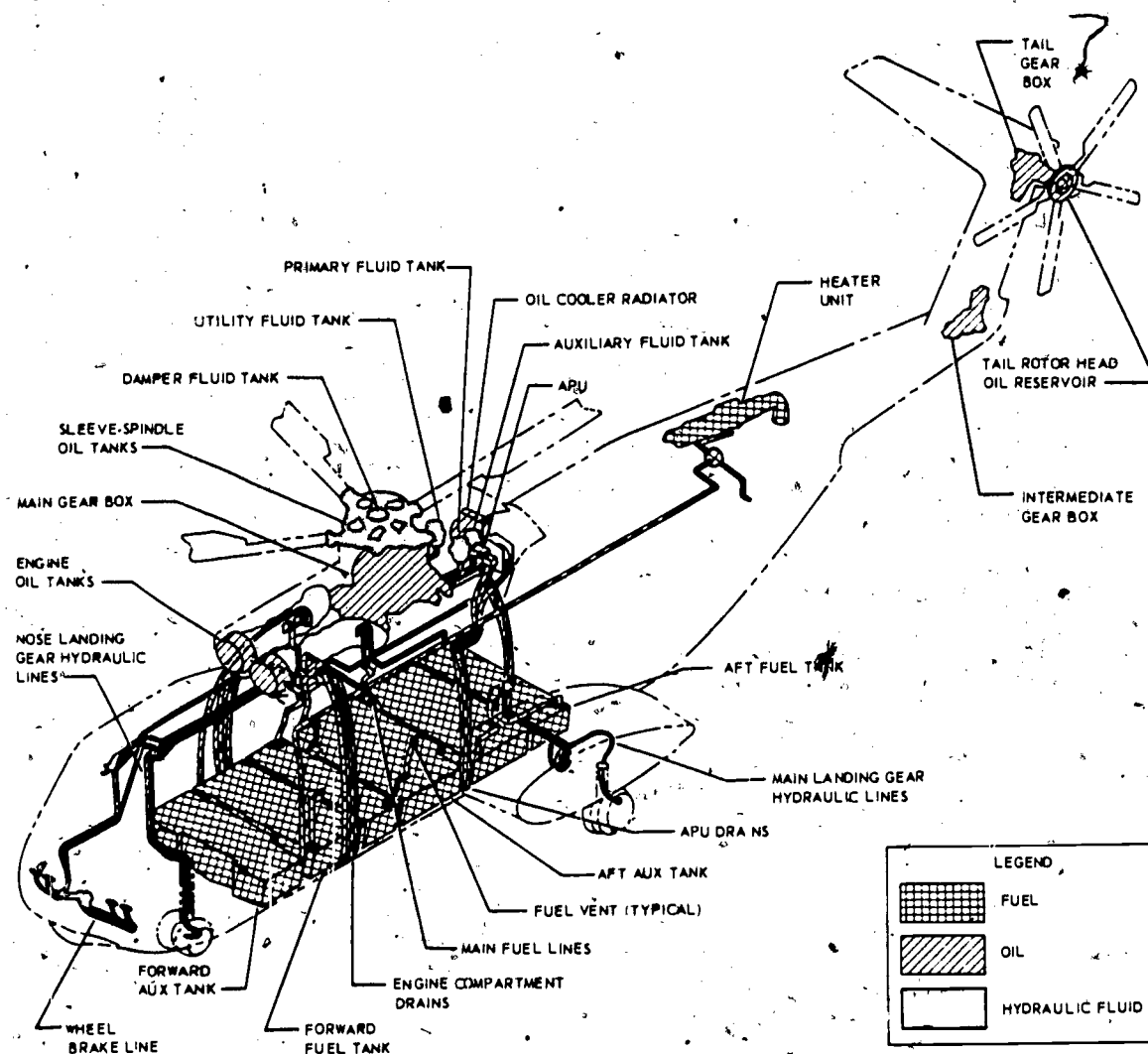


Figure 62. - Combustible materials - location diagram.

4.1. IF WASTE APPROVED FUELS

[illegible]

AMF M APT 1000 A

THE UNIVERSITY OF CHICAGO

IN THE FEDERAL BUREAU OF INVESTIGATION

CONFIDENTIAL

6. 1992 9 23 10:30 (10:30)

2026 L. A. ALONSO

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3. AT THE TURN OF THE CENTURY

... ..

1. ATLANTA INDUSTRIAL TRADING CO.
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ATT - A

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FIELD NUMBER OF SUBJECT: 58011 REC'D: 000000

RE: A SET OF PROBLEMS FOR THE

(1) ENGINE APU AND ALL GEAR BOXES

MR. L. 2347 NATO SYMBOL 0 150

HYDRAULIC FLUID PRIMARY AUXILIARY

AND CITY-TV SYSTEMS

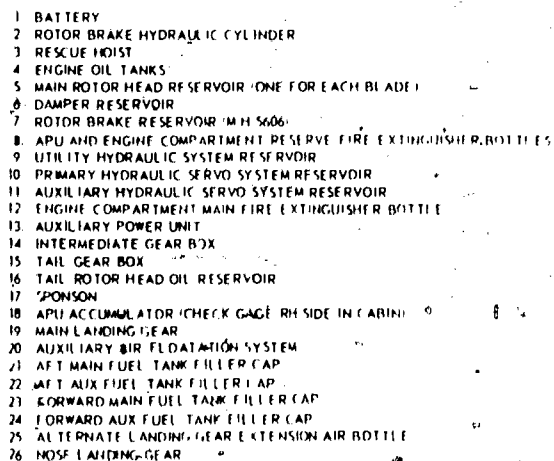
MIL-H-5606 NATO SYMBOL H-515

FIRE EXTINGUISHER AGENT

ENGINE AND AFTERSHOCK

PORTABLE (10),

PARTIALS



5 MAY 1971

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TABLE 3. SERVICING TABLE

FUEL SYSTEM

The following fuels have been recommended by the engine manufacturer. Fuel control settings must be adjusted when fuel types are being changed for projected use.

Material	Specification	Grade or Type	Fuel Control and Flow Divider Setting
Jet Fuel	MIL-J-5161G	I (JP-4 Referee)	JP-4
Jet Fuel	MIL-T-5624H	JP-4	JP-4
Turbo Fuel	Exxon Referee	4	JP-4
Turbo Fuel	Exxon	4	JP-4
Turbo Fuel	Exxon	1A	JP-4
Aircraft Turbine Fuel	ASTM	B	JP-4
Aircraft Turbine Fuel	ASTM	A	JP-4
Jet Fuel	Texaco	JP-4	JP-4
Canadian Fuel	3-GP-22C	2	JP-4
Jet Fuel	MIL-J-5161G	II (JP-5 Referee)	JP-5
Jet Fuel	MIL-T-5624H	JP-5	JP-5
Jet Fuel	Mobil	JP-5 (Referee)	JP-5
Turbo Fuel	Humble	A-1	JP-5
Turbo Fuel	Gulfflite	A	JP-5
Kerosene	Texaco	K-40	JP-5
Kerosene	Texaco	K-58	JP-5
Kerosene	Phillips	T.F.	JP-5
Turbine Fuel	Aeroshell	640K	JP-5
Turbine Fuel	Aeroshell	650K	JP-5
British Fuel	D. ENG. R.D.	2482	JP-5

Table 3 (cont.)

REPLENISH WITH

CAPACITY
U.S. MEASURE

SPECIAL INSTRUCTIONS

FUEL SYSTEM (cont.)

GRAVITY REFUELING, -1° to 0° NOSEDOWN, Laterally Level

Fuel JP-5 (C-2)
JP-4 used as
alternate

Total	
Forward Aux	184 gal
Forward Main	348 gal
Aft Aux	245 gal
Aft Main	345 gal
Net Capacity (Usable)	
Forward Aux	183.8 gal
Forward Main	344.52 gal
Aft Aux	245.7 gal
Aft Main	343.39 gal

NOTE

If prolonged operation is anticipated with fuel other than fuel indication set on flow divider and fuel control, adjustments should be reset to type fuel being used. (Refer to fuel density and flow divider adjustment, T. O. 1H-3(H)F-2-4.) Operation with a fuel or fuel mixture which differs from fuel type set on flow divider and fuel density set on fuel control can affect engine starting characteristics as indicated:

		Flow	Fuel	
*Fuel in Engine	Divider	Control	Probable	Effect on Start
Fuel System	Setting	Setting		
JP-4	JP-5	JP-4		Hot Start
JP-4	JP-4	JP-5		Cold Hangup
JP-4	JP-5	JP-5		Hot Start
JP-5	JP-5	JP-4		Slightly Warm
JP-5	JP-4*	JP-5		Cold Hangup
JP-5	JP-4	JP-4		Cold Hangup

*Fuel in engine system will not change for first start after refueling unless engine fuel system has been drained.

Engine starts after refueling with fuel other than type set on flow divider and fuel control should be monitored closely for possible over-temperature indications, which can be controlled through use of auxiliary start fuel valve. Should cold hangup be experienced, emergency engine control throttle can be used to accelerate to idle.

Cell Drain (Unusable)	
Forward Aux	0.2 gal
Forward Main	3.48 gal
Aft Aux	0.3 gal
Aft Main	2.61 gal

Ground helicopter to truck. Plug hose nozzle ground into grounding jack above each refueling receptacle, remove cap, and fuel as required.

Table 3. (cont.)

FUEL FILL WITH

CAPACITY
U.S. MEASURE

SPECIAL INSTRUCTIONS

PRESSURE REFUELING
150 GPM, -1° to 0° NOSEDOWN, LATERALLY LEVEL

Fuel JP-5 (C-2) Total
JP-4 used as alternate Forward Aux 175 gal (approx)
Forward Main 324 gal (approx)
Aft Aux 237 gal (approx)
Aft Main 328 gal (approx)

Net Capacity (Usable)
Forward Aux 174.8 gal (approx)
Forward Main 320.52 gal (approx)
Aft Aux 236.7 gal (approx)
Aft Main 325.39 gal (approx)

Cell Drain (Unusable)
Forward Aux 0.2 gal
Forward Main 3.48 gal
Aft Aux 0.3 gal
Aft Main 2.61 gal

NOTE

If prolonged operation is anticipated with fuel other than fuel indication set on flow divider and fuel control, adjustments should be reset to type fuel being used. (Refer to fuel density and flow divider adjustment, T. O. 1H-3(H)F-2-4.) Operation with a fuel or fuel mixture which differs from fuel type set on flow divider and fuel density set on fuel control can affect engine starting characteristics as indicated:

		Flow Fuel	
*Fuel in Engine Fuel System	Divider Setting	Control Setting	Probable Effect on Start
JP-4	JP-5	JP-4	Hot Start
JP-4	JP-4	JP-5	Cold Hangup
JP-4	JP-5	JP-5	Hot Start
JP-5	JP-5	JP-4	Slightly Warm
JP-5	JP-4	JP-5	Cold Hangup
JP-5	JP-4	JP-4	Cold Hangup

*Fuel in engine system will not change for first start after refueling unless engine fuel system has been drained.

Engine starts after refueling with fuel other than type set on flow divider and fuel control should be monitored closely for possible over-temperature indications, which can be controlled through use of auxiliary start fuel valve. Should cold hangup be experienced, emergency engine control throttle can be used to accelerate to idle.

CAUTION

MAIN GEAR BOX

To prevent damage to main gear box, do not mix grades of lubricating oil. If various grade oils (C-5, C-6, C-7, or C-8) are to be used, oil must be drained from main gear box and refilled with desired grade. If lubricating oils (C-5, C-6, C-7, or C-8) are being used prior to using lubricating oil (C-9), main gear box must

first be flushed with lubricating oil (C-9) and then refilled. Also, if switching from lubricating oil (C-9) to any other grade of lubricating oil (C-5, C-6, C-7, or C-8), flush the main gear box and then refill with appropriate oil. (Refer to T.O. 1H-3(H)F-2-4, Lubrication System - Flushing.)

Table 3 (cont.)

REPLENISH WITH

CAPACITY
U.S. MEASURE

SPECIAL INSTRUCTIONS

MAIN GEAR BOX (Cont)

CAUTION

If lubricating oil (C-9) is used at temperatures below 0° C. (32° F.), oil must be pre-heated.

Lubricating Oil
(C-5)
(C-6)
(C-7)
(C-8)
(C-9)

11 gal (approx)
*12 gal (approx)

Hinge down left transmission service platform and open transmission refill access panel. Inspect daily and replenish to FULL mark, if necessary, as indicated on sight level gage, on lower left side of gear box lower housing. Main gear box is full when oil is at bottom of inner circle. Refill when oil is at bottom of outer circle.

NOTE

Oil cooler is filled from main gear box.

INTERMEDIATE GEAR BOX

CAUTION

To prevent damage to intermediate gear box, do not mix grades of lubricating oil. If various grade oils (C-5, C-6, C-7, or C-8) are to be used, oil must be drained from gear box and refilled with desired grade. If lubricating oils (C-5, C-6, C-7, or C-8) are being used prior to using lubricating oil (C-9), intermediate gear box must first be flushed with lubricating oil (C-9) and then refilled. Also, if switching from lubricating oil (C-5, C-6, C-7, or C-8), flush the intermediate gear box and then refill with appropriate oil. (Refer to T.O. 1H-3(H)F-2-4, Intermediate Gear Box - Flushing.)

CAUTION

If lubricating oil (C-9) is used at Temperatures below 0° C. (32° F.), oil must be pre-heated.

Lubricating Oil
(C-5)
(C-6)
(C-7)
(C-8)
(C-9)

0.2 gal (approx)

Inspect daily and replenish to top of 0.375 diameter circle if necessary, as indicated on sight level gage on lower left side of gear box center housing. Intermediate gear box is full when oil is at top of 0.375 diameter circle. Refill when oil is at bottom of circle.

*Helicopters modified by T. C. T. O. 1H-3(H)F-512 and CG1480 and subsequent.

Table 3 (Cont.)

REPLENISH WITH	CAPACITY U.S. MEASURE	SPECIAL INSTRUCTIONS
TAIL GEAR BOX		
		CAUTION
		To prevent damage to tail gear box, do not mix grades of lubricating oil. If various grade oils (C-5, C-6, C-7, or C-8) are to be used, oil must be drained from gear box and refilled with desired grade. If lubricating oils (C-5, C-6, C-7, or C-8) are being used prior to using lubricating oil (C-9), tail gear box must first be flushed with lubricating oil (C-9) and then refilled. Also, if switching from lubricating oil (C-9) to any other grade of lubricating oil (C-5, C-6, C-7, or C-8), flush the tail gear box and then refill with appropriate oil. (Refer to T.O. 1H-3(H)F-2-4, Tail Gear Box - Flushing.
		CAUTION
		If lubricating oil (C-9) is used at temperatures below 0°C. (32°F.), oil must be preheated.
Lubricating Oil (C-5) (C-6) (C-7) (C-8) (C-9)	0.4 gal. (approx)	Replenish to FULL mark, if necessary, as indicated on sight level gage, on lower left side of gear box center housing.
MAIN WHEEL SHOCK STRUT		
		WARNING
Hydraulic Fluid (C-3) and Air	0.85 gal.	To prevent injury to personnel, discharge air before attempting to refill strut.
NOSEWHEEL SHOCK STRUT		
Hydraulic Fluid (C-3)	0.75 gal. (approx)	
WHEEL BRAKE SYSTEM		
Hydraulic Fluid (C-3)	Left System 9.2 fluid oz. (approx) Right System 5.8 fluid oz. (approx)	
EMERGENCY EXTENSION AIR BOTTLE		
Nitrogen (C-10A) or Air	3000 psi	Observe pressure gage on right transmission deck. Charge container at air chuck.

Table 3 (cont.)

REPLENISH WITH	CAPACITY U.S. MEASURE	SPECIAL INSTRUCTIONS
RESCUE HOIST		
Lubricating Oil (C-10)	Hoist 10 fluid oz.	Inspect weekly (25 to 30 hours) and replenish, if necessary.
Air	Accumulator 200 psi	
WINDSHIELD WASHER RESERVOIR		
Water	1.5 gal	When temperatures below 0°C (32°F) are expected, fill with solution of 80% anti-freeze (C-1) and 40% water.
FLOTATION AIR BOTTLES		
Air	3000 psi	Remove access panel forward sponson LH. Inspect daily and recharge, if necessary, to 3000 psi.
TURBINE OIL SYSTEM		
GRAVITY FILLING OIL TANK		
CAUTION		
To prevent damage to engine service platform and helicopter, do not let platform freefall when opening.		
Lubricating Oil (C-4) (C-5)	Total No. 1 oil tank 2.5 gal (approx) No. 2 oil tank 2.5 gal (approx)	Hinge down No. 1 and No. 2 engine service platforms. Visually inspect oil level through oil filler cap opening. Oil level shall be even with the filler neck screen. Inspect daily and replenish, if necessary. Drain and fill at engine overhaul.
NOTE		
When servicing engine oil system, use only like brands of oil because of possible incompatibility of different manufactured brands. Refer to paragraph 2-15.		
APU		
Lubricating Oil (C-4) (C-5)	Oil Tank 0.75 gal	Hinge down left transmission service platform and open APU access panel. Inspect daily and replenish to FULL mark, if necessary.
Air	Accumulator 1600 psi	(Refer to accumulator charging, T. O. 1H-3(H)F-2-3.)
PRIMARY FLUID TANK		
Hydraulic Fluid (C-3)	Fluid Tank 0.45 gal	With collective stick in low pitch, and cyclic pitch stick full forward, hinge down forward panel on left side of aft main rotor fairing and fill fluid tank to FULL mark.
AUXILIARY FLUID TANK		
Hydraulic Fluid (C-3)	Fluid Tank 0.45 gal	Hinge down aft panel on left side of main rotor fairing and fill fluid tank to FULL mark.

Table 3 (cont.)

REFLEENISH WITH		CAPACITY U.S. MEASURE	SPECIAL INSTRUCTIONS
UTILITY FLUID TANK			
CAUTION			
To prevent damage to utility fluid tank, ramp shall be in flight position, nose gear jacked and accumulator charged to operating pressure before servicing utility fluid tank.			
Hydraulic Fluid (C-3)	Fluid Tank	3.05 gal	Hinge down panel on right side of main rotor fairing. Fill fluid tank to FULL mark on sight level gage.
ROTOR BRAKE RESERVOIR			
Hydraulic Fluid (C-3)	Reservoir	3.2 fluid oz. (approx)	Fill rotor brake reservoir to FILL mark.
SLEEVE-SPINDLE OIL TANKS			
Lubricating Oil (C-9) (C-9A)	Oil Tank	0.14 gal	Inspect daily and replenish, if necessary. Fill to OIL LEVEL mark. Position blade over nose of helicopter to check proper level. Use lubricating oil (C-9A) when ambient temperature is above 15 F (-9.4 C) and lubricating oil (C-9) when ambient temperature is below 15 F (-9.4 C).
DAMPER FLUID TANK			
Hydraulic Fluid (C-3)	Damper Fluid Tank	38.4 fluid oz. (approx)	Inspect daily and replenish, if necessary. Fill to OIL LEVEL mark.
TAIL ROTOR HEAD RESERVOIR			
Lubricating Oil (C-9) (C-9A)	Reservoir	0.24 gal (approx)	Inspect daily and replenish if oil level falls below upper MIN mark. Fill to upper MAX mark. Use lubricating oil (C-9A) when ambient temperature is above 15 F (-9.4 C) and lubricating oil (C-9) when ambient temperature is below 15 F (-9.4 C).
DRIVE SHAFT VISCOUS DAMPER			
Oil (C-11)	Damper	4.25 fluid oz. (approx)	Remove inspection covers from tail drive shaft. Inspect daily for leakage and replenish, if necessary.
*Rotor heads, if received serviced with lubricating oil (C-4), must be drained and flushed with lubricating oil (C-9 or C-9A). For flush and fill procedures, refer to T.O. 1H-3(H) -2-5.			

TABLE 4. DRAINING TABLE

DRAIN	LOCATION	SPECIAL INSTRUCTIONS
Engine Oil Tank and Sumps	Forward Frame of Engine (two places)	Hinge down engine service platform, actuate drain valve plunger, and drain lubricant from oil tank into receptacle. Unscrew chip detectors from engine sumps and drain lubricant into receptacle.
NOTE		
Inspect magnetic chip detectors for metal particles.		
Main Gear Box	Main Gear Box Lower Cover	Remove center access cover from drip pan, unscrew magnetic chip detector from self-sealing fitting in lower housing, screw the drain fitting (T-3) into fitting, and drain lubricant into container.

TABLE 4 (Cont.)

DRAIN	LOCATION	SPECIAL INSTRUCTIONS
		NOTE
		Inspect magnetic chip detector for metal particles.
Intermediate Gear Box	Intermediate Gear Box Sump	Remove intermediate gear box access fairing, unscrew magnetic chip detector from self-sealing fitting in sump, screw drain fitting (T-3) into fitting, and drain lubricant into container.
Utility Fluid Tank	Right Aft Main Rotor Fairing	Hinge down right transmission service platform, open access panel at aft main rotor fairing, unscrew drain plug at bottom of fluid tank, and drain hydraulic fluid into container.
Primary Fluid Tank	Left Aft Main Rotor Fairing	Hinge down left transmission service platform, open access panel at aft main rotor fairing, unscrew drain plug at bottom of fluid tank, and drain hydraulic fluid into container.
Auxiliary Fluid Tank	Left Aft Main Rotor Fairing	Hinge down left transmission platform, open access panel at aft main rotor fairing, unscrew drain plug at bottom of fluid tank, and drain hydraulic fluid into container.
Damper Reservoir	Top of Main Rotor Head	Disconnect hydraulic damper hose at fluid tank and drain hydraulic fluid into container.
Reservoir	Tail Rotor Head	Unscrew drain plug and drain fluid into container.
Hull	Bottom Center of Tub (seven places)	Unscrew hull drain plugs at bottom center of tub and drain.
WARNING		
To prevent fire hazard, exercise proper precautions when draining fuel cell.		
Fuel Cell	Bottom of Tub Forward and Aft Fuel Cells and Forward and Aft Aux Cells (four places)	Hinge down fuel drain cover, attach suction hoses, actuate spring-loaded drain valve, and drain fuel into fuel truck.
Fuel Cell Sump	Bottom of Tub Forward and Aft Fuel Cells and Forward and Aft Aux Cells (six places)	Using screwdriver, actuate spring-loaded drain valve and drain fuel into container.
Fuel Purifier Drain	Bottom of Tub, Forward of 2nd Cabin Window LH (one place) Forward of 1st Cabin Window RH (one place)	Using screwdriver, actuate spring-loaded drain valve.
Fuel Filter	Left Fuselage, Aft of 2nd Cabin Window	Hinge open access panel and open drain cock.
Fuel Filter	Right Fuselage, Aft of 2nd Cabin Window	Hinge open access panel and open drain cock.
Pitot Static Tubes	Electronics Compartment, LH (one place), RH (two places). Cockpit canopy (one place) LH and RH.	Hinge up nose door and unscrew cap. Enter cockpit and unscrew cap.
Sponson	Bottom LH and RH Sponson (eight places)	Unscrew sponson drain plugs.

TABLE 4. (Cont.)

Rotating Navigation Light

Oil Tank (Sleeve-Spindle)

APU

Bottom of Tub between Sponsons

Main Rotor Head Sleeve-Spindle

Left Aft Main Rotor Fairing

Remove one mounting screw.

Remove plug at bottom of vertical hinge cap and plug on bottom side of sleeve.

Open APU access panel, unscrew drain plug at bottom forward of sump, and drain into container.

TIRE SERVICING

Main landing gear tires should be inflated between 70 and 75 psi pressure. Nose landing gear tires should be inflated between 75 and 80 psi pressure. These pressure ranges are adequate for all loadings and anticipated climatic conditions. Maintain tire inflation at prescribed levels, and check at least once every seven days. During cold weather operations (-15° F. or lower), when helicopter tires are serviced in a warm area and the helicopter is subsequently parked outside, tires may become underinflated or even go flat. If this problem is encountered, tubes may be installed in the tubeless tires.

WARNING

To prevent injury to personnel, do not attempt to use high-pressure air to service tires. Air pressure in excess of 500 psi could cause wheel to explode. Air pressure in 1,000 to 3,000 psi range will damage air valves.

CAUTION

To prevent damaging tires and wheels, tires paired in dual wheel configuration shall have matching diameters.

FIRE PROTECTION SYSTEM SERVICING

1. Check container gages to make sure they indicate at or above the minimum pressure specified on the Temperature-Pressure decal. (See figure 64.) Referenced temperature should closely approximate that of container, and the temperature should be checked only when the helicopter has been in

CF₃ BRTEMPERATURE-PRESSURE
RELATION TABLE

TEMPERATURE DEGREES F.	MINIMUM ALLOWABLE PRESSURE
-40	100
-20	120
0	150
20	180
40	230
60	280
80	350
100	430
120	520
140	630

Figure 64. - Fire extinguisher servicing decal.

a location of constant temperature long enough for heat in transmission compartment to dissipate and container temperature to equal ambient temperature. Do not check the temperature if the helicopter has been recently moved to an area of different temperature. If check must be made at conditions other than indicated, temperature used must be that of the container itself, or that

inside the fairing immediately around the container. Chart in figure 64 will apply with temperature taken, using either method.

2. Lightly tap gage guard with pencil to overcome internal friction in gage which could prevent correct reading.

3. If pressure indication, or container weight, is below minimum specified, container must be returned to an activity capable of performing necessary tests and servicing.

AUXILIARY FLOAT AIR BOTTLE SERVICING.

After actuation of auxiliary flotation system, perform steps 1 through 8. If pressure has dropped below 2,650 psi, perform steps 4 through 8.

1. Remove left-hand sponson access cover.
2. Stow handle in cabin to closed position.
3. Reset mechanical valve on air bottle by applying pressure on arm and closing.
4. Remove cap and loosen outer hex nut by turning counterclockwise with hose attached.

NOTE

Filling air bottle too rapidly causes air to heat and expand, resulting in excessive pressures.

5. Connect hose from source of nitrogen (C-10A) or a compressor with a rated output of two cubic feet per minute and equipped with a mechanical moisture separator; fill air bottle to 3,000 psi.

6. With hose attached to valve, tighten outer hex nut by turning clockwise with 50 to 70 inch-pounds torque. Disconnect hose.

7. Using soap solution, test for leaks. Air bubbles indicate leakage.

8. After air bottle has cooled, if pressure is below 2,650 psi, repeat steps 4 through 7.

HYDRAULIC SYSTEMS SERVICING

Hydraulic systems servicing includes checking, filling, and draining of the primary, auxiliary, utility fluid tanks, damper fluid tanks, and rotor brake reservoir. For detailed servicing instructions, see figures 63 and 65 and tables 3 and 4.

POWER PLANT AND TRANSMISSION SYSTEMS SERVICING

Power plant and transmission systems servicing includes checking, filling, and draining the No. 1 and No. 2 demountable power plants, auxiliary power unit (APU), and gear boxes. For detailed servicing instructions, see figures 63 and 65 and tables 3 and 4.

CAUTION

To make sure of proper servicing of engines or gear boxes when changing from one type of oil to another, drain the system and refill it with a new type of oil. Then bring the system to operating temperature, redrain, and refill with a new type of oil.

FUEL SYSTEM SERVICING

The fuel system may be gravity or pressure refueled and gravity defueled. For detailed servicing instructions, see figures 63, 65, and tables 3 and 4. For precautionary measures to be observed, refer to T.O. 00-25-212 and appropriate Coast Guard instructions.

COLD WEATHER SERVICING

During extreme cold weather, it may be advisable (at the discretion of operating unit) to use fuel system icing inhibitor (C-3A) mixed with helicopter fuel. Fuel system icing inhibitor (C-3A) is intended

to eliminate icing and, when properly mixed, has no adverse effects upon fuel cells or engine operation. The inhibitor has an additional capability of eliminating slime growth in the helicopter fuel tanks due to its biocidal action. Note that the fuel system icing inhibitor is intended to eliminate icing conditions only and does not eliminate the need to drain sumps to eliminate water from helicopter fuel systems.

CAUTION

Fuel system icing inhibitor (C-3A) must not be mixed in helicopter fuel cell.

Mix fuel system icing inhibitor (C-3A) at a concentration of 0.10 to 0.15 percent by volume with approved helicopter fuel (JP-4 or JP-5). Fuel must be treated with inhibitor (C-3A) in fuel truck or storage tank, at discretion of operating unit. Ensure that treated mixture is thoroughly mixed and agitated to completely disperse inhibitor.

EXAMPLE: Per 1,000 gallons of fuel, add 1.0 to 1.5 gallons of fuel system icing inhibitor (C-3A), and mix/agitate mixture until thoroughly dispersed.

PRESSURE REFUELING

WARNING

To avoid the possibility of explosion, make sure no radar is operating within 500 feet of helicopter.

1. Ground helicopter and fuel truck.

NOTE

On helos modified by T.O. 568 and CC 1481 and subsequent; ensure fueling pressure does not exceed 50 psi.

2. Hinge down pressure fueling access door.

3. With PRI TEST and SEC TEST switches released, fuel cells will fill to capacity.

4. Turn off fueling unit when desired quantity is aboard or fuel flow stops.

5. Remove fueling nozzle, replace protective cap, close access door, remove all grounds.

NOTE

Tanks may be gravity fueled through filler caps on left side of helicopter.

GRAVITY DEFUELING (See figure. 66.)

WARNING

To avoid the possibility of explosion, make sure no radar is operating within 500 feet of helicopter.

1. Ground helicopter and fuel truck.
2. Open fuel cell drain valve covers.
3. Connect suction hose from truck to valve and open valve. Drain all cells this way.
4. To completely drain fuel cells, drain fuel from sumps and filters through sump and filter drains.

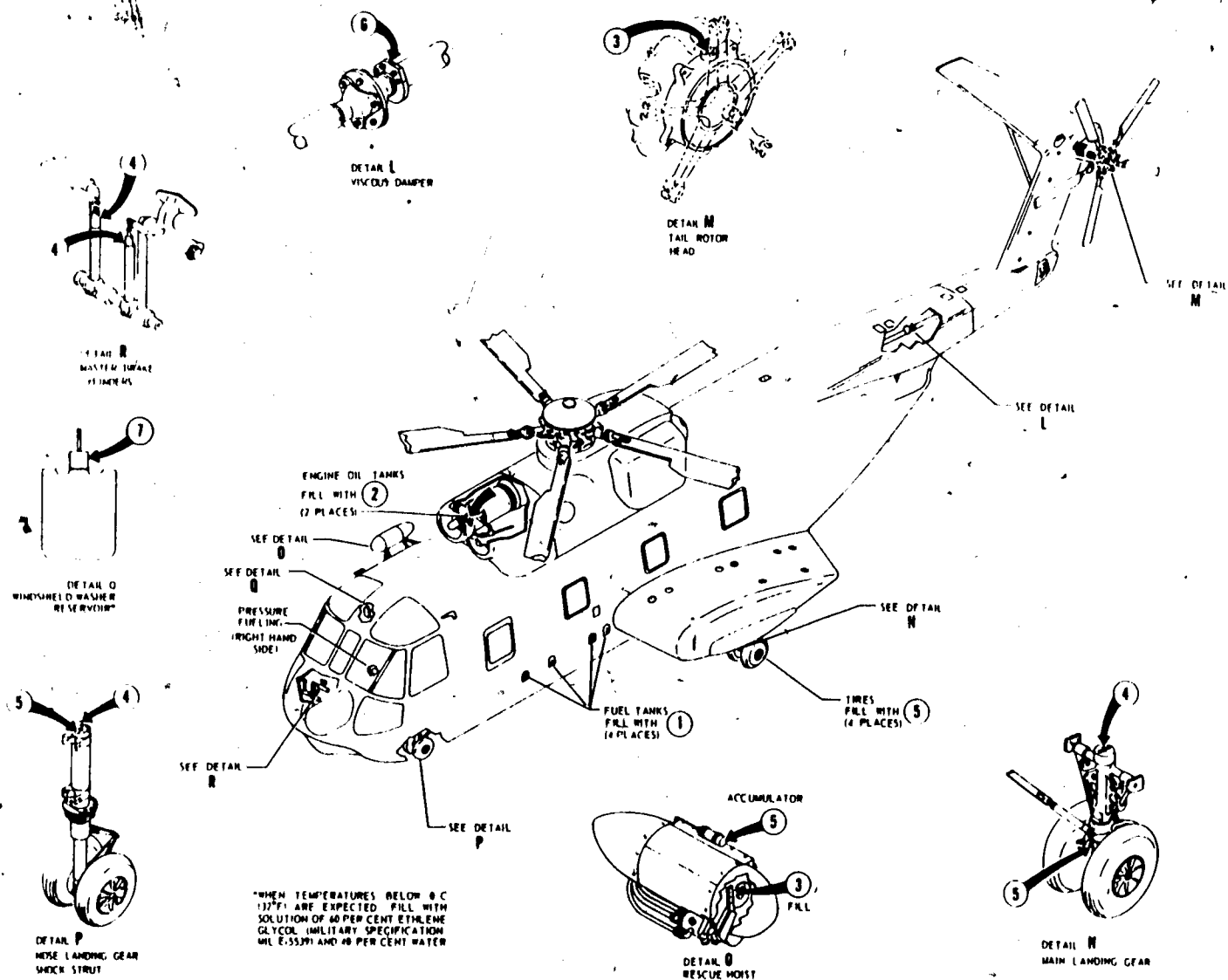


Figure 65. - Airframe group servicing diagram (Sheet 1).

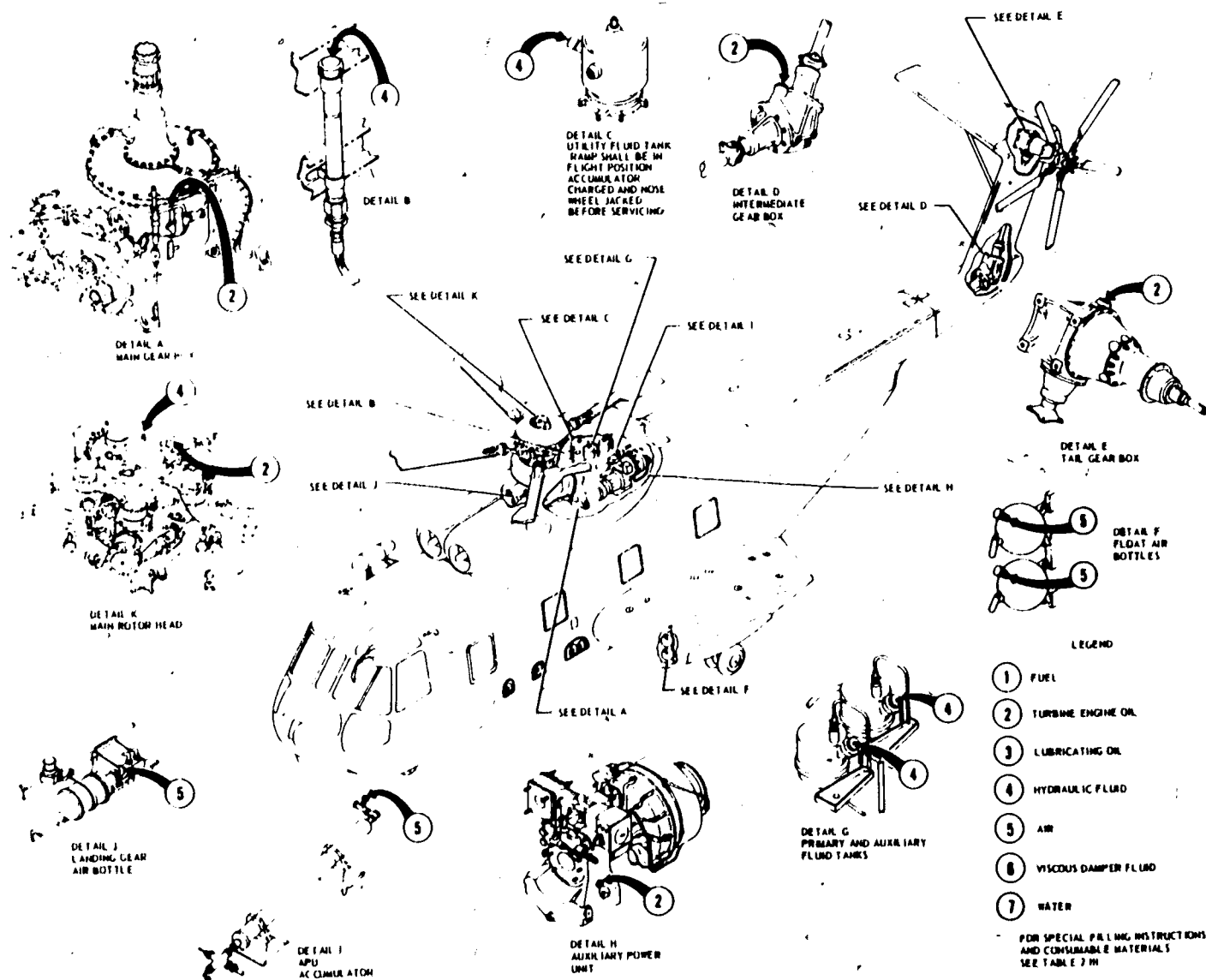


Figure 65. - Airframe group servicing diagram (Sheet 2).

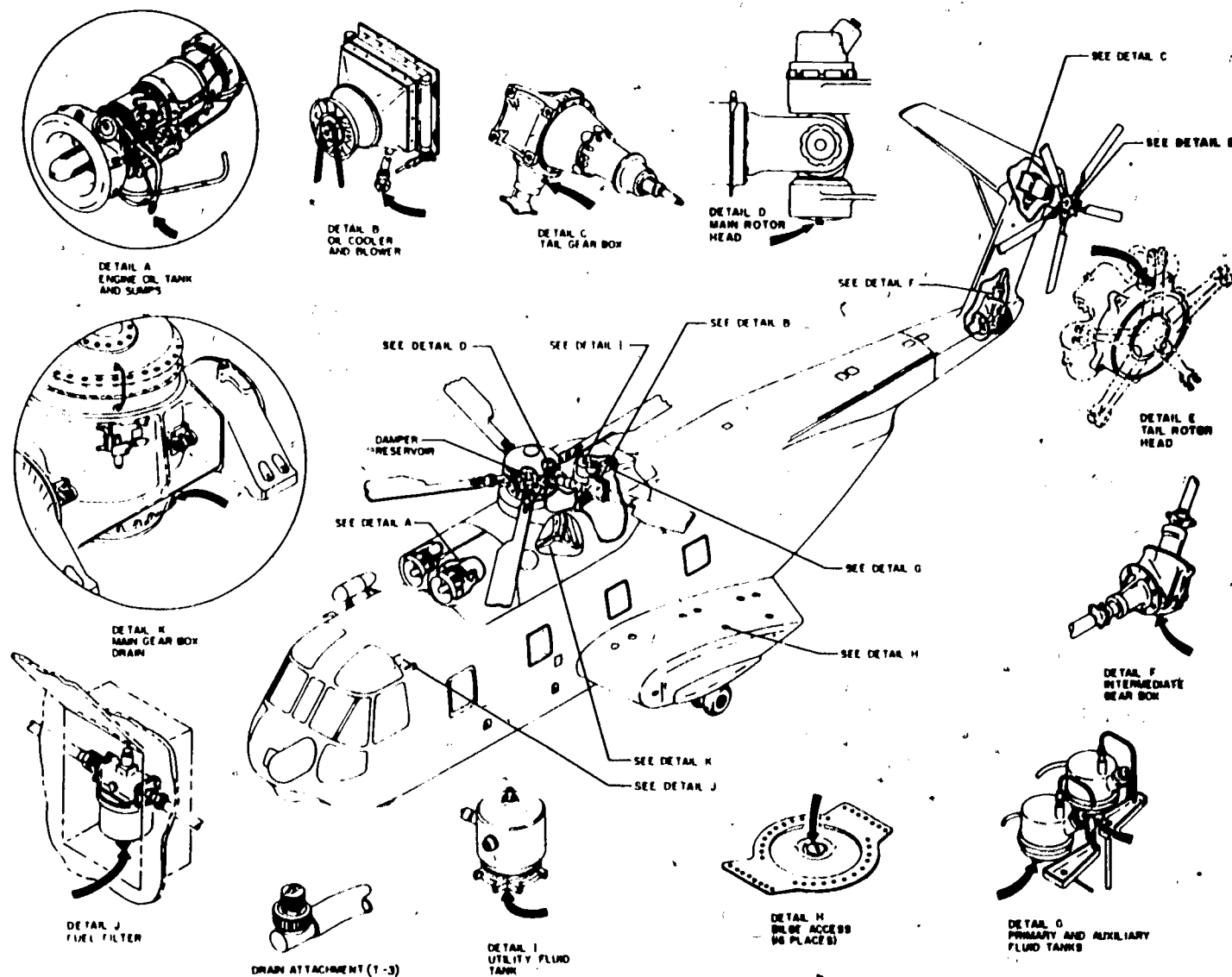


Figure 66. - Draining diagram (Sheet 1).

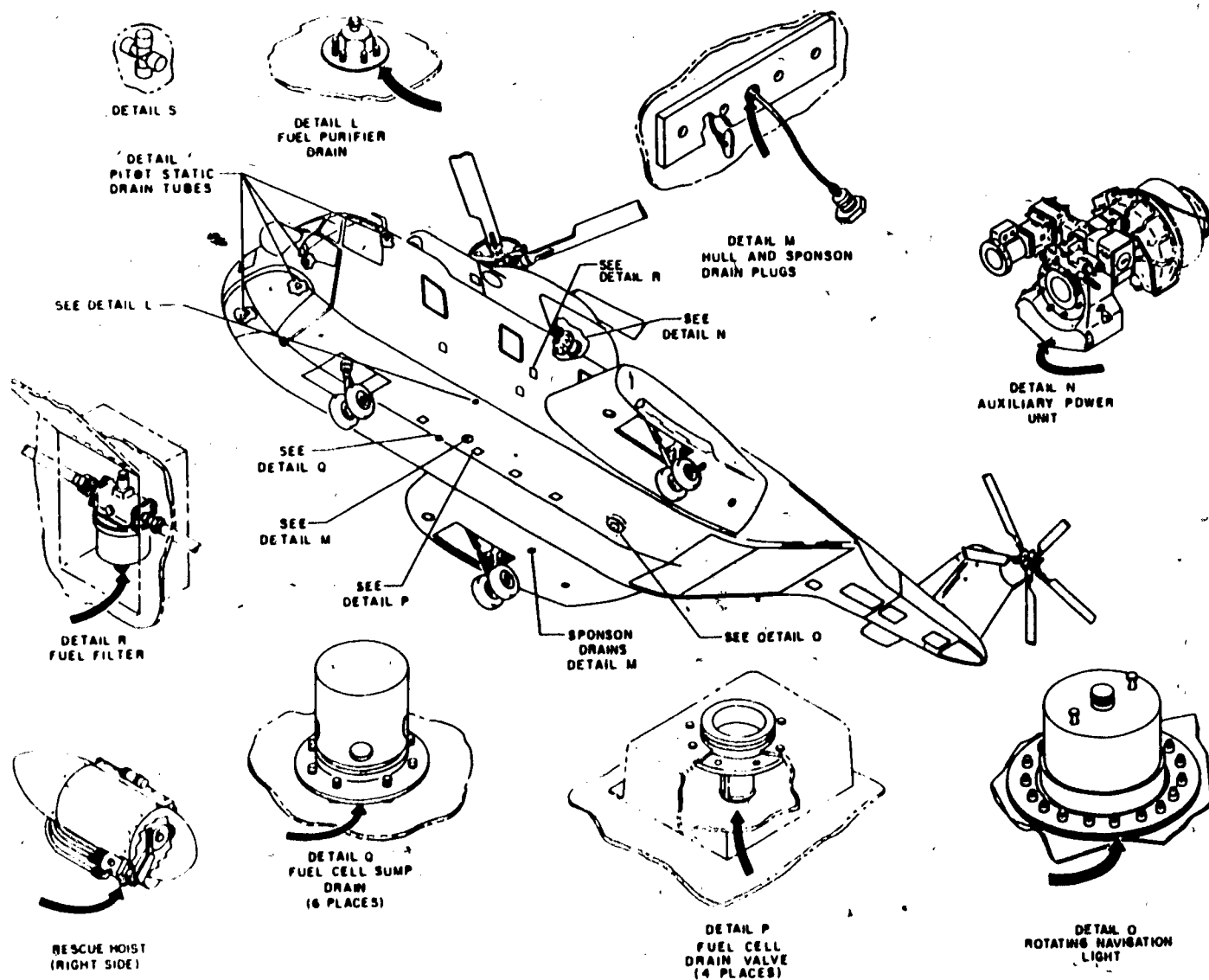


Figure 66. - Draining diagram (Sheet 2).

REVIEW

In this section we have covered HH-3F helicopter ground handling and servicing.

(Now answer the following review questions.)

55. What is the MAXIMUM HH-3F towing speed?

- A. 5 mph
- B. 10 mph
- C. 15 mph
- D. 20 mph

55.-A (Refer to page 85)

56. When the helicopter is properly tied down, it can withstand a MAXIMUM of _____ knot winds.

- A. 20
- B. 30
- C. 50
- D. 65

56.-D (Refer to page 87)

57. What should you do to prevent rupturing of diaphragm seals in the main rotor head during the next rotor engagement after cold weather parking?

- A. Hangar the helicopter
- B. Cover the rotor head
- C. Tie down the blades in full lag position
- D. De-ice the helicopter before engagement

57.-C (Refer to page 90)

58. The capacity of the intermediate gear box is _____ gallon(s).

- A. 0.1
- B. 0.2
- C. 1.2
- D. 1.0

58.-B (Refer to page 98)

59. Main landing gear tire pressure on the HH-3F should be between _____ psi.

- A. 65 - 70
- B. 70 - 75
- C. 75 - 80
- D. 80 - 85

59.-B (Refer to page 103)

INTRODUCTION TO FLIGHT MECHANIC'S SYLLABUS GROUND PHASE

FOREWORD

Successful rescue missions are accomplished by the coordination of skills between the pilot and crew.

The pilots have a training syllabus that requires them to be skilled in the art of flying.

You, as a flight mechanic, must have a working knowledge of the equipment used aboard the helicopter. You must be familiar with and accomplished in the professional skills, techniques, and procedures used on rescue missions.

This syllabus is designed specifically to give you the required training to become a proficient and safety-conscious flight mechanic.

You must be supervised by a qualified instructor as you complete this booklet. To indicate that you have satisfactorily demonstrated or explained as item, the instructor will initial and date (abbreviated 1-1-80) the "S" block. If your performance is not satisfactory, the instructor will initial and date the "U" block. The instructor will then indicate in the instructor's remarks section the reason for the unsatisfactory mark. If you are not prepared or fail to satisfactorily complete an item, the instructor should counsel you and indicate what preparation or additional training is required.

This is a composite ground/flight syllabus derived from close examination of the many syllabi in existence at various air stations and is designed to meet the needs of all air stations. Commanding officers may deviate from this standard as required to meet local mission requirements and operational limitations. In revising this standard syllabus for local use, it should be remembered that a proficient, safe, and standard search and rescue air crewman is the goal of the program.

Reprinted 12/81

CREWMEMBER

I. Objectives

- A. After completing this phase, the student will be able to:
1. Perform taxi signalman duties safely, using standard hand signals.
 2. Perform the line duties required of a SAR aircrewmember (servicing, etc.)
 3. Tow an aircraft, using the proper equipment and procedures.
 4. Use the pyrotechnics and SAR equipment safely.
 5. Plot a course, using the proper navigation equipment and procedures.
 6. Perform a preflight, thruflight, and post flight, using the proper guidelines.
 7. Make a topping adjustment.
 8. Operate the APU.
 9. Wash and rustlick the engine.
 10. Install auxiliary flotation bags.
 11. Demonstrate in-flight duties.
 - a. Fuel dumping operation
 - b. Safety inspections
 - c. Operation of aircraft communications equipment
 12. Demonstrate emergency egress procedures from Flight Mechanic, Avionicsman, and Hoist Operator's positions.
- B. The student must accomplish the ground phase to the instructor's satisfaction before it can be signed off.
- C. The student must complete the ground phase before the flight phase can begin.
- D. Completion of this ground training will give the student the background needed to be a good line crewmember and a good aircrewmember.

GROUND 1

I. AIRCRAFT GROUND HANDLING

Instructor will have the student accomplish the following:

A. Aircraft start and launch

1. Using the proper procedures and safety precautions, stand the fire guard for aircraft start and launch.

S U

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B. Aircraft taxiing

1. Demonstrate the proper procedures and hand signals for aircraft taxiing.
2. Describe the safety precautions used during acft. taxi evolution.

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C. Aircraft securing

1. Demonstrate proper procedures to follow during engine shut-down.
2. Use the proper procedures to tie down an aircraft.
3. Show how the equipment for securing an aircraft is used.
4. Show the location of the main landing gear locking pins and show how they are used.

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- D. Demonstrate a working knowledge of general line operations.

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II. GENERAL

- A. Progress
- B. Knowledge
- C. Judgement
- D. Attitude

III. INSTRUCTOR'S REMARKS:

Instructor Signature /Date

III. INSTRUCTOR'S REMARKS:

GROUND 2

I. AIRCRAFT TOWING

Student will accomplish the following under guidance of the instructor:

- A. Complete prestart check of tow tractor (gas, oil, etc.).
- B. Operate tow tractor.
- C. Complete tow bar safety check and hook up to the aircraft.
- D. Hook up tow tractor to tow bar and aircraft.
- E. Ensure that the proper tow crew is in position, and has been briefed on emergency/normal stops.
- F. Tow aircraft.
- G. Demonstrate the aircraft towing safety precautions.

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(Student should go through this lesson as many times as it takes to complete the lesson to the instructor's satisfaction.)

II. GENERAL

- A. Progress
- B. Knowledge
- C. Judgment
- D. Attitude

Instructor Signature / Date

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GROUND 3

I. AIRCRAFT SERVICING

Instructor will have student accomplish the following:

A. Fueling

1. Complete prestart check of fuel truck.
2. Operate fuel truck, demonstrating proper procedures and safety precautions, including proper static grounding sequence.
3. Demonstrate knowledge of the fueling and defueling operation on the HH-3F.
4. Fuel aircraft, including procedures for hydrant and cabinet fueling.

B. Oil and hydraulic fluid

1. Identify the proper oil to be used in the engines, transmission, intermediate gear box, and tail gear box.
2. Using the proper oil, replenish the engines, transmission, intermediate and tail gear boxes.
3. Using the proper hydraulic fluid, replenish the primary, auxiliary, and utility hydraulic systems.

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4. Describe the proper procedures to be followed in accomplishing items 2 and 3 in this section.

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C. Lubrication

1. Using the proper grease, equipment, and procedures, lubricate the landing gear.

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- D. Observe the proper procedures and safety precautions in each of the described operations.

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II. GENERAL

- A. Progress
- B. Knowledge
- C. Judgment
- D. Attitude

III. INSTRUCTOR'S REMARKS:

Instructor Signature /Date

GROUND 4

I. Aircraft SAR and Survival Equipment

Instructor will have student demonstrate a thorough knowledge of the following items: (Only the items at your unit until the standard SAR board is developed. Extra spaces provided for items not listed.)

A. SAR equipment

1. Message bottles
2. Float lights
3. Salt packs
4. Cable splicer
5. Cargo straps
6. Space blankets
7. Trail lines (with weak links
and weighted bag)
8. Flashlight
9. Cable cutter
10. Shroud cutter
11. Aldis lamp
12. Gloves
13. Crash axe
14. MK 25 arming/disarming device
15. Boathook
16. Survival knife
17. Life rafts
18. Dye markers
19. Rescue basket
20. Rescue platform
21. Survival vest(s)
22. A/C fire extinguisher

S U

[illegible]

23. Survivor's sling
24. Sea anchor
25. Sea drogue
26. First aid kits
27. Aircrewmember's safety harness
28. Chalkboard
29. AMBU standard resuscitator
30. Stoke's litter
31. Portable salvage pump
32. Splints
33. Ear plugs
34. Survival kit
35. Camera
36. Wool blankets
37. Body bag
38. Air-to-ground phone
39. Tow handle
40. Sav-a-life flotation device
41. Auxiliary flotation collars
42. Bilge pump
- 43.
- 44.
- 45.

S U

[illegible]

- B. Rescue equipment used (but not in A/C)

- ## 1. Night Sun searchlight

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C. Pyrotechnics

1. MK-25
2. MK-58
3. MK-13
4. MK-79

D. Emergency radios (Survival radios for emergency comms, lowering to survivor for help to ground comms):

- | | | |
|----|-----|----|
| 1. | PRC | 63 |
| 2. | PRC | 90 |
| 3. | URT | 33 |

II. COMMUNICATIONS

S U

Instructor will have student perform the following:

A. ICS

1. Operate avionicsman's ICS control boxes.

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B. AN/ARC-94

1. Operate control box function switches.
2. Make frequency changes.
3. Contact aeronautical station using proper voice procedures.
4. Transmit operation and position reports.
5. Maintain abbreviated radio log.

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III. General

- A. Progress
- B. SAR/Rescue equipment knowledge
- C. Judgment
- D. Attitude

IV. Instructor's Remarks:

Instructor Signature / Date

GROUND 5

I. NAVIGATION

S U

Instructor will have student accomplish the following:

A. Interpret charts.

1. Read charts.
2. Identify types of charts.
3. Estimate distances.
4. Identify approach plate.
5. Identify enroute supplements.

B. Use navigation equipment

1. Compass
2. Plotter
3. Dividers
4. Pilot's computer

- C. Plot a given course, giving headings, distance, enroute time, and any other information as desired. (Use 80 kts.)

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- D. Show a working knowledge of the following electronic navigation equipment:

1. Direction finders
2. VHF/NAV
3. ADF
4. TACAN

II. GENERAL

- A. Progress
- B. Knowledge
- C. Judgment
- D. Attitude

S U

III. INSTRUCTOR'S REMARKS:

GROUND 6

I. INSPECTIONS

Instructor will have the student accomplish the following:

A. Preflight inspection

S U

1. Perform a preflight inspection in accordance with CAMP Maintenance Requirement Cards.

2. Sign off preflight on CO-4377 using proper procedures (sample form).

B. Thruflight inspection

1. Perform a thruflight inspection in accordance with CAMP Maintenance Requirement Cards.

2. Sign off thruflight on CO-4377 using proper procedures (sample form).

C. Postflight inspection

1. Perform a postflight inspection in accordance with CAMP Maintenance Requirement Cards.

Instructor Signature /Date

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2. Sign off postflight according to station instructions.

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D. Weekly inspections

1. Perform weekly inspections in accordance with CAMP Maintenance Requirement Cards.

E. Special inspections

1. Perform special inspections in accordance with CAMP Maintenance Requirement Cards.

a. After water landings

b. Wash aircraft

II. APU operation

Complete the APU Start/Run checklist, using the proper procedures and safety precautions.

III. Engine wash and rustlick

Complete the engine wash and rustlick operation, using the proper procedures.

IV. GENERAL

- A. Progress
B. Knowledge
C. Judgment
D. Attitude

V. INSTRUCTOR'S REMARKS:

Instructor Signature /Date

GROUND 7

I. IN-FLIGHT DUTIES

Instructor will have student accomplish the following:

S U

- A. Make a topping adjustment and describe the proper procedures.

- B. Show the location of the fuel dump valves and describe the fuel dumping operation.

- C. Perform in-flight inspections.

- D. Show the proper procedures for installing the auxiliary flotation bags.

- E. Demonstrate a knowledge of aircraft systems.

- F. Demonstrate a knowledge of in-flight emergency duties.

- G. Secure aircraft after flight.

II. GENERAL

- A. Progress
B. Knowledge
C. Judgment
D. Attitude
E. Crew coordination

III. INSTRUCTOR'S REMARKS:

GROUND 8

GROUND CHECKOUT

To complete this section, use an available MH-3P on the line. You will also need a hydraulic jenny and electrical power or the APU. You must complete this section before you can begin your flight phase.

AIRCRAFT AND SAR EQUIPMENT

Student will demonstrate proper procedures for the following (location, knowledge, and use):

- A. Crewmember duties
- B. ICS procedures
- C. Radios
- D. SAR board equipment
- E. Survival equipment
- F. Pyrotechnics
- G. Taw bag
- H. Rescue equipment:
 - 1. Basket
 - 2. Litter
 - 3. Sling
 - 4. Rescue platform
- I. Flotation bottles and inflation handle
- J. LPU-10/P combination SRU-21/P life vest
- K. Heater, battery, and C/B panels
- L. Hoist controls, hoist shear switch, and hot mic.
- M. Aircrewmember's safety harness
- N. Aldis lamp
- O. Hover trim stick (Optional)
- P. Variable speed hoist control

S U

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Instructor Signature /Date

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S

- Q. Finger installation
- R. Night sun
- S. Datum marker buoy
- T. Float light
- U. AMBU resuscitator
- V. Save-a-life flotation device
- W. Expendable surface current probe

S	U

VI. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude

VII. INSTRUCTOR'S REMARKS (required):

I. SAR STANDBY EQUIPMENT

Student will properly use:

- A. Dewatering pump
- B. Loud-hailer

III. RESCUE EQUIPMENT OPERATION

Student will:

- A. Complete rescue checklist
- B. Operate hoist using:

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- 1. Basket (2 ea.)
- 2. Sling (2 ea.)
- 3. Litter (2 ea.)

IV. PLATFORM

Student will:

- A. Rig platform
- B. Demonstrate platform pickup

V. EMERGENCY ITEMS AND PROCEDURES

Student will show the location of and/or explain the following:

- A. Emergency exits (Demonstrate emergency egress procedures from Avionicsman, Flight Mechanic and Hoist Operator's positions).
- B. Fire extinguisher
- C. Emergency exit lights
- D. First aid kits
- E. In-flight fire
- F. Smoke and fume elimination
- G. Ditching procedures

Instructor Signature /Date

INTRODUCTION TO FLIGHT MECHANICS SYLLABUS FLIGHT PHASE

I. OBJECTIVES

- A. After completing this phase, the student will be able to:
1. Accomplish a successful hoist.
 2. Perform a platform pickup using the correct terminology and procedures.
 3. Use proper procedures to making inflight adjustments, inspections, procedures, and handling inflight emergencies.
- B. To demonstrate this knowledge and training, the student will satisfactorily complete this flight syllabus.

II. GENERAL

- A. The flight training syllabus is designed to help you achieve proficiency, standardization, and safety in the operation of the aircraft.
- B. The ultimate goal is to save lives. Don't be the one responsible for an unsuccessful mission.
- C. Flight preparation
1. You are expected to study the syllabus and be prepared to answer all questions concerning emergencies, performance, and procedures.
 2. The instructor will give additional instructions during the flight phase as needed.
 3. The instructor will expect you to initiate all checklists at the appropriate time.
 4. All emergencies will be simulated, unless otherwise specified by the pilot or instructor. You will be expected to treat all such simulations as actual emergencies.

5. The instructor will emphasize the importance of standardization, proper procedures, and emergency duties during all portions of the flight phase.
 6. The student will ensure that all required equipment is on the airplane before each flight. (Training and SAR)
 7. A briefing will be held before each flight and a debriefing after each flight for going over the day's flight and reviewing different procedures and equipment. This is a required function.
 8. If a boat is not available for completing the tasks in the Flight 4 section of the flight syllabus, the pilot may allow you to hoist over another suitable object.
 9. Preflight the aircraft and inform the aircraft commander of any discrepancies you may have found. Remove pins from landing gear.
 10. Remove engine plugs and pitot cover and stow them properly.
 11. Make sure any special equipment required for that particular flight is aboard the aircraft.
- NOTE: You should report to the aircraft no less than 60 minutes before flight time. If you are going on a cross-country flight, make sure you have a credit card for fuel and oil and know how to use it. Also have blade boots and necessary equipment for aircraft tiedown.
12. Brief any passengers on the use of parachutes and life vests and on the emergency procedures. Inform the aircraft commander you have done this.

13. Stand by for APU and engine start. Remain connected to ICS and next to the aircraft for rotor engagement.
14. Show the pilot you have the landing gear pins, and get into the aircraft after removing the chocks.
15. Stop the ladder and make ready for flight.
16. Respond to the pilot's checkoff list as necessary.
17. Put on life vest if needed.
18. Make sure everyone aft is ready for flight before giving the pilot a "ready" for takeoff.
19. When directed by pilot check the droop stops for engagement. Report when engaged.
20. After the rotor system is stopped, install the gear lock pins and chocks.
21. Empty ash trays and pick up any trash in the aircraft.
22. Inform the aircraft commander of any discrepancies you may have noticed during flight.
23. Make a walk-around inspection of the aircraft before leaving.
24. If you are away from the home station, service the aircraft as directed by the aircraft commander. Secure aircraft as necessary.

FLIGHT TRAINING FLIGHT 1

FLIGHT TIME

AIRCRAFT FAMILIARIZATION

I. FLIGHT PREPARATION

A. Briefing—discuss:

1. Flight controls
2. Aircraft in general

S

B. Preflight (instructor and student)

II. FLIGHT PHASE (student in jump seat)

A. Pilot will demonstrate and explain:

1. Flight controls
 - a. In a hover
 - b. In normal flight pattern
 - c. AFCS-off flight

2. Instruments

- a. Engine
- b. Transmission
- c. Flight

B. Avionicsman will demonstrate and explain: (Student at avionicsman position)

1. Radios

- a. ICS
- b. VHF
- c. UHF
- d. HF
- e. FM

2. Navigation Items

S

a. Loran

C. Instructor will demonstrate and explain:

1. Hoist

- a. Boat underway
- b. Boat dead in water
- c. Land

2. Hover trim operation (Optional)

3. Platform pickups

III. DEBRIEFING (review)

A. Day's flight

IV. INSTRUCTOR'S REMARKS (required):

FLIGHT 2

FLIGHT TIME

LAND HOIST

I. FLIGHT PREPARATION

A. Briefing—discuss:

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- 1. Sling
- 2. Basket
- 3. Location and use of cable cutters and shear system
- 4. ICS failure
- 5. Hydraulic override

B. Preflight (instructor and student)

II. FLIGHT PHASE

Complete rescue checklist

A. Hoists (various altitudes) (variable speed hoist control)

- 1. Sling (min.3)
- 2. Basket (min.3)

B. Use of standard hoisting terminology

C. Loss of ICS system

D. Instructor will use a basket to hoist student over land area

E. Use of hydraulic override

Instructor Signature /Date

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III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

FLIGHT 3

FLIGHT TIME

LAND HOIST

FLIGHT PREPARATION

A. Briefing—discuss:

- 1. Litter
- 2. Fouled cable procedures
- 3. Electrical system failure
- 4. Hover trim
- 5. Lookout duties

B. Preflight (student, instructor follow-up)

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FLIGHT PHASE

A. Hoists (various altitudes)

- 1. Sling (min.2)
- 2. Basket (min.3)
- 3. Litter (min.3)

B. Fouled hoist (simulated)

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C. Use of hydraulic override

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D. Use of standard hoisting terminology

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E. Use of rescue checklist

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F. Use of hover trim (Optional)

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G. Lookout duties

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Instructor Signature /Date

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H. Land drop of wind indicating devices and message bottles.

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III. DEBRIEFING (review)

A. Day's flight

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FLIGHT 4

FLIGHT TIME

IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature /Date

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BOAT HOIST

S U

I. FLIGHT PREPARATION

A. Briefing

- 1. Sling/basket underway
- 2. Platform pickups
- 3. No platform type pickups
- 4. Pax. briefing

II. FLIGHT PHASE

A. Hoists (underway)

- 1. Sling (min. 5)
- 2. Basket (min. 5)

B. Platform work

- 1. Platform pickups (min. 3)
- 2. No platform pickups (min. 1)

C. Use of rescue checklist

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D. Use of standard hoisting terminology

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E. Fouled cable (simulated)

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F. Pax. briefing (simulated)

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III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

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V. INSTRUCTOR'S REMARKS (required):

FLIGHT 5

FLIGHT TIME

BOAT HOIST

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I. FLIGHT PREPARATION

A. Briefing

- 1. Trail line ops.

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- B. Preflight (student and instructor follow-up)

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II. FLIGHT PHASE

A. Hoists (underway)

- 1. Sling (min. 2)
- 2. Basket (min. 2)
- 3. Litter (min. 2)

B. Hoists (drifting)

- 1. Sling (min. 2)
- 2. Basket (min. 2)
- 3. Litter (min. 2)

C. Trail line (underway)

- 1. Trail line--basket (min. 1)
- 2. Trail line--litter (min. 1)

- D. Use of standard hoisting terminology

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- E. Use of rescue checklist

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- F. Use of hydraulic override valve

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Instructor Signature /Date

III. DEBRIEFING (review)

A. Day's flight

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FLIGHT 6

IV. GENERAL

- A. Progress
- B. Aircrew member knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

FLIGHT TIME

BOAT HOIST

S U

I. FLIGHT PREPARATION

- A. Briefing (pump drops)
- B. Preflight (student, instructor follow-up)

II. FLIGHT PHASE

- A. Hoists underway (various altitudes)
 - 1. Sling (min. 3)
 - 2. Basket--trail line (min. 3)
 - 3. Litter--trail line (min. 3)
- B. Hoists drifting (Various altitudes)
 - 1. Basket--trail line (min. 2)
 - 2. Litter--trail line (min. 2)
 - 3. Trail line with pump (min. 2 each of direct and indirect delivery methods)
- C. Use of standard hoisting terminology
- D. Use of Rescue checklist
- E. Hoist malfunctions

III. DEBRIEFING (review)

A. Day's flight

Instructor Signature /Date

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FLIGHT 7

IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

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V. INSTRUCTOR'S REMARKS (required):

FLIGHT TIME

COMMUNICATIONS AND SEARCH PROCEDURES

I. FLIGHT PREPARATION

A. Briefing

- 1. Nav. equipment and nav. bag
- 2. Communications equipment
- 3. Search procedures
- 4. Pyrotechnics

B. Preflight (instructor follow-up)

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II. FLIGHT PHASE (Crewmember in avionicsman's seat)

A. Communications

- 1. Student will demonstrate use of:

- a. HF
- b. VHF
- c. ICS
- d. Loran

- 2. OPS normal report

B. Search procedures

Student will demonstrate and explain:

- 1. Scanning techniques
- 2. Search procedures
- 3. Sight picture
- 4. Sea evaluation

Instructor Signature /Date

C. Pilot will demonstrate an auto-rotation

D. Pyrotechnics launch procedures.
Student will launch the following:

1. MK-25
2. MK-58
3. Location devices
4. Datum marker buoy
5. Float light

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature /Date

FLIGHT 8

FLIGHT TIME

NIGHT BOAT HOISTS

I. FLIGHT PREPARATION

A. Briefing

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1. Night boat operations
2. In-flight emergencies

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B. Preflight (student, instructor follow-up)

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II. FLIGHT PHASE

A. Platform pickups (min. 2)

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B. Hoists underway (various altitudes)

1. Sling (min. 2)
2. Basket (min. 2)
3. Litter (min. 2)
4. Litter trail line (min. 2)
5. Pump (direct delivery method)

C. Hoists . drifting (various altitudes)
"with trail line only"

1. Basket (min. 2)
2. Litter (min. 2)
3. Pump (indirect delivery method)

D. Night sun operation

1. At conclusion of flight with rotor (only) stopped, trainee

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will assist ground crew in mounting Night Sun. Trainee will then conduct a 15-minute checkout and disassemble it after the flight.

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III. DEBRIEFING

A. Night's flight

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IV. GENERAL

- A. Progress
- B. Aircrewmember knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature /Date

FLIGHT 9

FLIGHT TIME

CHECK FLIGHT
(Boat Ops.)

FLIGHT PREPARATION

S U

- A. Briefing (day's flight)
- B. Preflight (student accomplish, instructor observe)

FLIGHT PHASE

- A. Sea evaluation
- B. Platform pickups
- C. Hoists underway (various altitudes)

- 1. Basket
- 2. Litter
- 3. Sling
- 4. Litter trail line

- D. Hoists drifting (various altitudes)

- 1. Basket
- 2. Litter
- 3. Sling
- 4. Litter trail line
- 5. Dewatering pump delivery (direct method)

- E. Dewatering pump trail line (drop)
- F. Use of standard hoisting terminology
- G. Use of rescue checklist
- H. ICS failure

- I. Fouled-cable procedure
- J. In-flight emergencies
- K. Use of hydraulic override
- L. Instructor hoist student
(boat underway)
- M. Student hoist instructor
(boat underway)
- N. Use of radios
- O. Ditch and egress (use of
markers, pyrotechnics and
hypothermia considerations)

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III. GENERAL

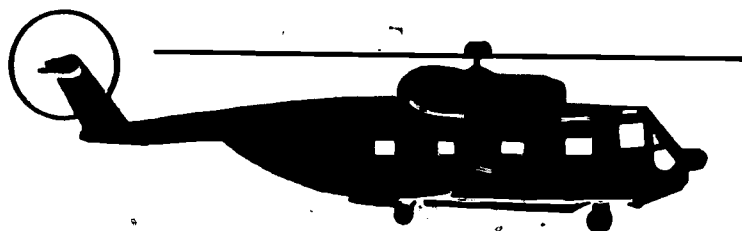
- A. Aircrewmember knowledge
- B. Judgment
- C. Attitude
- D. Summarize check flight
- E. Crew coordination

IV. INSTRUCTOR'S REMARKS (required):

Instructor Signature /Date

HH - 3F

HOIST OPERATOR STANDARDIZED SYLLABUS



FOREWORD

This training syllabus will qualify you as a hoist operator on the HH-3F helicopter.

In addition to your other duties, you may be required to complete this syllabus according to unit policy.

Whether you are engaged in making an actual hoist or assisting the flight mechanic, this syllabus will provide you with the necessary training to become a proficient hoist operator.

A qualified instructor must supervise the student as he completes this booklet. To indicate that the student has satisfactorily demonstrated or explained an item, the instructor will enter his initials and the abbreviated date (1-1-76) in the "S" block. If the student's performance is not satisfactory, the instructor will initial and date the "U" block. He will then indicate in the instructor's Remarks section the reason for the unsatisfactory mark. If the student is not prepared or fails to satisfactorily complete an item, the instructor should counsel him and indicate what preparation or additional training is required.

This is a composite ground/flight syllabus derived from close examination of the many syllabi in existence at various Air Stations and is designed to meet the needs of all Air Stations. Commanding officers may deviate from this standard as required to meet local mission requirements and operational limitations. In revising this syllabus for local use, it should be remembered that a proficient, safe, and standard search and rescue aircrewman is the goal of the program.

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CREWMAN

FAA AC 70-403

DEPARTMENT OF TRANSPORTATION
U. S. Coast Guard (10/79)

U. S. Coast Guard Institute
94442A

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INTRODUCTION TO HOIST OPERATOR'S SYLLABUS

I. OBJECTIVES

A. After completing this syllabus, the student will be able to:

1. Demonstrate emergency egress procedures from hoist operators position.
2. Accomplish a successful hoist using the correct terminology and procedures.
3. Perform a platform pickup using the correct terminology and procedures.
4. Perform dewatering pump deliveries using the correct terminology and procedures.

B. To demonstrate this knowledge and training, the student will satisfactorily complete this hoist operators syllabus.

II. GENERAL

A. The hoist operator's training syllabus is designed to help you achieve proficiency, standardization, and safety in the performance of your hoisting duties.

B. The ultimate goal is to save lives. Don't be the one responsible for an unsuccessful mission.

C. Flight preparation

1. You are expected to study the syllabus and be prepared to answer all questions concerning emergencies, performance, and procedures. You should also be familiar with all rescue equipment.
2. The instructor will give additional instructions during the flight as needed.
3. The instructor will expect you to initiate all checklists at the appropriate time.
4. All emergencies will be simulated, unless otherwise specified by the pilot or instructor. You will be expected to treat all such simulations as actual emergencies.

5. The instructor will emphasize the importance of standardization, proper procedures, and emergency duties during all portions of the flight.

6. The student will ensure that all required equipment is on the aircraft before each flight.

7. A briefing will be held before each flight and a debriefing after each flight, for going over the day's flight and reviewing different procedures and equipment. This is a required function.

8. If a boat is not available for completing the tasks in the Flight 3 section of the syllabus, the pilot may allow you to hoist over another suitable object.

GROUND 1

GROUND CHECKOUT

To complete this section, use an available HH-3F on the line. You will also need a hydraulic Jenny and electrical power or the APU. You must complete this section before you can begin your flight phase.

I. AIRCRAFT AND SAR EQUIPMENT

Student will demonstrate proper procedures for the following (location, knowledge, and use):

- A. Hoist operator's duties
- B. ICS procedures
- C. SAR board equipment
- D. Survival equipment
- E. Rescue equipment:

1. Basket
2. Litter
3. Sling
4. Rescue platform

- F. Hoist controls, hoist shear switch, and hot mic.
- G. Aircrewman's safety harness
- H. Aldis lamp
- I. Hover trim stick
- J. Variable speed hoist control
- K. Night sun
- L. Datum marker buoy
- M. Float light
- N. AMBU resuscitator
- O. Save-a-life flotation device
- P. First aid kits
- Q. Demonstrate emergency egress procedures from hoist operators position.

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II. SAR STANDBY EQUIPMENT

Student will properly use:

- A. Dewatering pump
- B. Loud-hailer

III. RESCUE EQUIPMENT OPERATION

Student will:

- A. Complete rescue checklist
- B. Operate hoist using:

1. Basket (2 ea.)
2. Sling (2 ea.)
3. Litter (2 ea.)

IV. PLATFORM

Student will:

- A. Rig platform
- B. Demonstrate platform pickup

V. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude

VI. INSTRUCTOR'S REMARKS (required):

Instructor Signature/Date

S U

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FLIGHT 1

FLIGHT TIME

LAND HOIST

I. FLIGHT PREPARATION

A. Briefing--discuss:

1. Sling
2. Basket
3. ICS failure
4. Hydraulic override

H. FLIGHT PHASE

Complete rescue checklist:

A. Hoists (various altitudes) (variable speed hoist control)

1. Sling (min. 3)
2. Basket (min. 3)

- B. Use of standard hoisting terminology
- C. Loss of ICS system
- D. Instructor will use a basket to hoist
- E. student over land area
- Use of hydraulic override

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature/Date

FLIGHT TIME

LAND HOIST

S U

I. FLIGHT PREPARATION

A. Briefing--discuss:

1. Litter
2. Hydraulic override
3. ICS failure
4. Hover trim

II. FLIGHT PHASE

A. Hoists (various altitudes)

1. Sling (min. 2)
2. Basket (min. 3)
3. Litter (min. 3)

- B. Fouled hoist (simulated)
- C. Use of hydraulic override
- D. Use of standard hoisting terminology
- E. Use of rescue checklist
- F. Use of hover trim

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

Instructor Signature/Date

FLIGHT 3

FLIGHT TIME

BOAT HOIST

S U

I. FLIGHT PREPARATION

A. Briefing

1. Sling/basket underway

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II. FLIGHT PHASE

A. Hoists (underway)

1. Sling (min. 5)
2. Basket (min. 5)

B. Platform work

1. Platform pickups (min. 3)
2. No platform pickups (min. 1)

- C. Use of rescue checklist
- D. Use of standard hoisting terminology
- E. Fouled cable (simulated)

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

Instructor Signature/Date

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FLIGHT 4

FLIGHT TIME

BOAT HOIST

I. FLIGHT PREPARATION

A. Briefing

1. Trail line ops.

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II. FLIGHT PHASE

A. Hoists (underway)

1. Sling (min. 2)
2. Basket (min. 2)
3. Litter (min. 2)

B. Hoists (drifting)

1. Sling (min. 2)
2. Basket (min. 2)
3. Litter (min. 2)

C. Trail line (underway)

1. Trail line--basket (min. 1)
2. Trail line--litter (min. 1)

- D. Use of standard hoisting terminology
- E. Use of rescue checklist
- F. Use of hydraulic override valve

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

S	U

V. INSTRUCTOR'S REMARKS (required):

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Instructor Signature/Date

FLIGHT 5

FLIGHT TIME

BOAT HOIST

I. FLIGHT PREPARATION

S U

A. Briefing

1. Dewatering pump deliveries

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II. FLIGHT PHASE

A. Hoists underway (various altitudes)

1. Sling (min. 3)
2. Basket--trail line (min. 3)
3. Litter--trail line (min. 3)

B. Hoists drifting (various altitudes)

1. Basket--trail line (min. 2)
2. Litter--trail line (min. 2)
3. Trail line with pump (min. 2)

- C. Use of standard hoisting terminology
- D. Use of rescue checklist
- E. Hoist malfunctions

III. DEBRIEFING (review)

A. Day's flight

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IV. GENERAL

S U

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature/Date

FLIGHT 6

FLIGHT TIME

NIGHT BOAT HOISTS

I. FLIGHT PREPARATION

A. Briefing

1. Night's flight
2. Dewatering pump delivery

II. FLIGHT PHASE

A. Platform pickups (min. 2)

B. Hoists underway (various altitudes)

1. Sling (min. 2)
2. Basket (min. 2)
3. Litter (min. 2)
4. Litter trail line (min. 2)

C. Hoists drifting (various altitudes)

1. Basket (min. 2)
2. Litter (min. 2)
3. Dewatering pump

a. Trail line

D. Night sun operation

1. At conclusion of flight with rotor (only) stopped, trainee will assist ground crew in mounting Night Sun. Trainee will then conduct a 15-minute checkout and disassemble it after the flight.

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III. DEBRIEFING (review entire syllabus)

IV. GENERAL

- A. Progress
- B. Aircrewman knowledge
- C. Judgment
- D. Attitude
- E. Crew coordination

V. INSTRUCTOR'S REMARKS (required):

Instructor Signature/Date

FLIGHT 7

FLIGHT TIME

CHECK FLIGHT (Boat Ops.)

I. FLIGHT PREPARATION

A. Briefing (day's flight)

II. FLIGHT PHASE

A. Sea evaluation
B. Platform pickups
C. Hoists underway (various altitudes)

1. Basket
2. Litter
3. Sling
4. Litter trail line

D. Hoists drifting (various altitudes)

1. Basket
2. Litter
3. Sling
4. Litter trail line
5. Dewatering pump delivery (direct method)

E. Dewatering pump trail line (drop)
F. Use of standard hoisting technology
G. Use of rescue checklist
H. ICS failure

- I. Fouled-cable procedure
- J. Use of hydraulic override
- K. Instructor hoist student (boat underway)
- L. Student hoist instructor (boat underway)

III. GENERAL

- A. Aircrewman knowledge
- B. Judgment
- C. Attitude
- D. Summarize check flight
- E. Crew coordination

IV. INSTRUCTOR'S REMARKS (required):

Instructor Signature/Date